MONTANA

RULES AND REGULATIONS

PERTAINING TO

RADIATION CONTROL

1969

MontColl
R
344.786
MONTANA

ONTANA STATE DEPT. OF HEALTH

91-001

A. McKANE, M.D.
5195 ELK RIDGE ROAD
MISSOULA, MONTANA

Medical & Technical Photography

REFERENCE DEPARTMENT

City-County Library of Missoula
R
344.786
MONTANA

MONTANA COLLECTION

artcraft

JAN 2 0 1987

3 3144 00109 9693

STATE OF MONTA
RULES AND REGULATIONS PERTAINING TO RADIATION CONTROL

TABLE OF CONTENTS

PART A

General Provisions

Page
Sec. A.1 Purpose and Policy 1
A.2 Authority 1
A.3 Scope 1
A.4 Definitions 2
A.5 Units of Radiation Dose 6
A.6 Units of Radioactivity 8
A.7 Violations 8
A.8 Impounding 9
A.9 Additional Requirements 9
A.10 Applications for Exemptions 9
A.11 Prohibited Use 9
A.12 Communication 9

PART B

Licensing and Registration

Sec. B.1 Purpose 10
B.2 Scope 10

Exemptions

Sec. B.3 Source Material 10
B.4 Radioactive Materials 12
B.5 Carriers 14
B.6 U. S. Atomic Energy Commission Contractors 14
B.7 Other Exemptions 14

Licenses

Sec. B.20 Types of Licenses 15
B.21 General Licenses—Source Material 15
B.22 General Licenses—Radioactive Material other than Source Material 16

Specific Licenses

Sec. B.24 Filing of Application for Specific Licenses 27
B.25 General Requirements for the Issuance of Specific Licenses 28

R
344.786
MONTANA

039316

TABLE OF CONTENTS—(Continued)

Page

B.26 Special Requirements for Issuance of Certain Specific Licenses for Radioactive Materials 28
B.27 Special Requirements for Specific Licenses of Broad Scope 35
B.30 Issuance of Specific Licenses 38
B.31 Specific Terms and Conditions of Licenses 39
B.32 Expiration of Licenses 39
B.33 Renewal of Licenses 39
B.34 Amendment of Licenses at Request of Licensee 40
B.35 Department Action on Applications to Renew or Amend 40
B.36 Inalienability of Licenses 40
B.37 Persons Possessing a License for Source, Byproduct, or Special Nuclear Material in Quantities Not Sufficient to Form a Critical Mass on Effective Date of these Regulations 40
B.38 Persons Possessing Radioactive Material other than Agreement Material on Effective Date of these Regulations 40
B.40 Transfer of Material 41
B.50 Modification, Revocation, and Termination of Licenses 41

Registration

Sec. B.60 Registration 42

Records, Inspections, and Tests

Sec. B.70 Records 43
B.71 Inspections 43
B.72 Tests 44
B.73 Film Badge Services 44

Reciprocity

Sec. B.90 Reciprocal Recognition of Licenses 44

Transportation

Sec. B.100 Intrastate Transportation of Radioactive Materials 46
Schedule A 46
Schedule B 47
Schedule C 49
Schedule D 52
Schedule E 53

MISSOULA PUBLIC LIBRARY
MISSOULA, MONTANA 59802

TABLE OF CONTENTS—(Continued)

PART C

Standards for Protection Against Radiation

Page

Sec. C.1 Purpose and Scope 56

Permissible Doses, Levels, and Concentrations

Sec. C.2 Exposure of Individuals to Radiation in Restricted Areas........ 56
C.3 Determination of Accumulated Dose........ 57
C.4 Exposure of Individuals to Concentrations of Radioactive Material in Restricted Areas 58
C.5 Exposure of Minors 59
C.6 Permissible Levels of Radiation from External Sources in Non-Restricted Areas 60
C.7 Concentration in Effluents to Unrestricted Areas........ 60
C.8 Orders Requiring Furnishing of Bio-Assay Services........ 62

Precautionary Procedures

Sec. C.9 Surveys 62
C.10 Personnel Monitoring 63
C.11 Caution Signs, Labels, and Signals........ 63
C.12 Exceptions From Posting Requirements 67
C.13 Instruction of Personnel 68
C.14 Storage of Sources of Radiation........ 68

Waste Disposal

Sec. C.15 General Requirement 68
C.16 Method of Obtaining Approval of Proposed Disposal Procedures 68
C.17 Disposal by Release into Sanitary Sewerage Systems........ 69
C.18 Disposal by Burial in Soil 69
C.19 Disposal by Incineration 69

Records, Reports, and Notification

Sec. C.20 Records of Surveys, Radiation Monitoring, and Disposal........ 70
C.21 Reports of Theft or Loss of Source of Radiation........ 70
C.22 Notification of Incidents 70
C.23 Report to Former Employees and Others of Exposure to Radiation 71
C.24 Reports of Overexposures and Excessive Levels and Concentrations 72
C.25 Notice to Employees and Others of Exposure to Radiation 73
C.26 Vacating Premises 73

TABLE OF CONTENTS—(Continued)

Page

Appendix A 74

Appendix B 87

Form MRH-30 88

Form MRH-31 90

PART D

Radiation Safety Requirements for Industrial Radiographic Operations

Sec. D.1 Purpose 94

D.2 Scope 94

D.3 Definitions as Used in this Part 94

Equipment Control

Sec. D.4 Limits on Levels of Radiation for Radiographic Exposure Devices and Storage Containers 95

D.5 Locking of Sources of Radiation 95

D.6 Storage Precautions 95

D.7 Radiation Survey Instruments 95

D.8 Leak Testing, Repair, Tagging, Opening Modification, and Replacement of Sealed Sources 96

D.9 Quarterly Inventory 97

D.10 Utilization Logs 97

Personal Radiation Safety Requirements for Radiographers and Radiographer's Assistants

Sec. D.20 Limitations 97

D.21 Operating and Emergency Procedures 98

D.22 Personnel Monitoring Control 98

Precautionary Procedures in Radiographic Operations

Sec. D.30 Security 99

D.31 Posting 99

D.32 Radiation Surveys and Survey Records 99

D.33 Special Requirements for Radiography-Employing Radiation Machines 99

Appendix A 100

PART E

Use of X-Rays in the Healing Arts

Sec. E.1 Scope 102

E.2 Definitions 102

TABLE OF CONTENTS—(Continued)

Page
E.3 General Safety Provisions 103
E.4 Prohibited Use 105
E.5 Fluoroscopic Installations 105
E.6 Dental Radiographic Installations 108
E.7 Veterinary Medicine Radiographic Installations 110
E.8 Radiographic Installations other than Dental and Veterinary Medicine 111
E.9 Special Requirements for Mobile Diagnostic Radiographic Equipment 114
E.10 Special Requirements for Chest Photofluorographic Installations 114
E.11 Therapeutic X-Ray Installations 115
Table 1 119

PART F

Use of Sealed Radioactive Sources in the Healing Arts

Sec. F.1 Scope 120
F.2 Interstitial, Intracavitary and Superficial Applications 120
F.3 Gamma-Beam Therapy 121

PART G

Regulations Requiring Stabilization of Mill Tailings Piles

Sec. G.1 Scope 124
G.2 Permissible Concentrations and Levels of Radiation 124
G.3 Stabilization of Tailings Piles, and Ponds from Inactive Mills 124

Part A

GENERAL PROVISIONS

Sec. A. 1 Purpose and Policy

(a) The responsibility for the administration of a radiological health program in Montana has been delegated to the State Department of Health. Recognizing this responsibility, these Radiological Health Regulations are promulgated.

(b) These regulations provide for the licensing by the Montana State Department of Health of certain byproduct, source, and special nuclear material currently licensed by the United States Atomic Energy Commission, in accordance with and on the effective date of, an agreement between the governor and the Atomic Energy Commission. Through this agreement, the State of Montana becomes an "Agreement State" and assumes the licensing authority in Montana currently exercised by the Atomic Energy Commission.

(c) These regulations also provide for the licensing of naturally occurring and accelerator produced radioactive materials, and registration of radiation machines. The effective date of this portion of the regulations shall be 45 days after the date of adoption.

Sec. A. 2 Authority

(a) The Montana State Legislature authorized the State Department of Health to formulate and administer the radiological health program under an act to institute and maintain in the board of health a regulatory program for sources of ionizing radiation; to provide for compatibility with the standards and regulatory provisions of the federal government for a single effective system of regulation of persons handling radioactive materials or equipment using such materials and setting forth penalties for non-compliance. This legislation is hereinafter referred to as the "Act".

Sec. A. 3 Scope

(a) Except as otherwise specifically provided, these regulations apply to all persons in Montana who receive, possess, use, transfer, own, or acquire any source of radiation; provided, however, that nothing in these regulations shall apply to any person to the extent such person is subject to regulation by the U. S. Atomic Energy Commission.

(b) The provisions of Part **C**, Radiation Protection Standards, of these regulations shall not be interpreted as limiting the intentional exposure of patients to radiation for the purpose of diagnosis or therapy by doctors of the healing arts, duly licensed by the State of Montana and engaged in the lawful practice of their profession or administered by other persons acting under the direct supervision of a licensed practitioner.

Sec. A. 4 Definitions

(a) As used in these regulations:

1. **Act** means Radiation Control Act, approved by the Montana legislature, February 1967.
2. **Agreement State** means any state with which the United States Atomic Energy Commission enters or has entered into an effective agreement under section 274b of the Atomic Energy Act of 1954 as amended (73 Stat. 689).
3. **Airborne Radioactive Material** means any radioactive material dispersed in the air in the form of dusts, fumes, mists, vapors or gases.
4. **Byproduct Material** means any radioactive material (except special nuclear material) yielded in or made radioactive by exposure to the radiation incident to the process of producing or utilizing special nuclear material.
5. **"Calendar quarter"** means any period determined according to either of the following subdivisions:

    (i) The first period of any year may begin on any date in January provided that the second, third and fourth periods accordingly begin on the same date in April, July and October, respectively, and that the fourth period extend into January of the succeeding year, if necessary to complete a three-month quarter. During the first year of use of this method of determination by a licensee or registrant, the first period for that year shall also include any additional days in January preceding the starting date for the first period.

    (ii) The first period in a calendar year of 13 complete, consecutive calendar weeks; the second period in a calendar year of 13 complete, consecutive calendar weeks; the third period in a calendar year of 13 complete, consecutive calendar weeks; the fourth period in a calendar year of 13 complete, consecutive calendar weeks. Alternatively, the four periods may consist of the first 14 complete consecutive calendar weeks; the next 12 complete, consecutive calendar weeks; the next 14 complete, consecutive calendar weeks; and the last 12 complete, consecutive calendar weeks. If at the end of a calendar year there are any days not falling within a complete calendar week of that year, such days shall be included (for purposes of these regulations) within the last complete calendar week of that year. If at the beginning of any calendar year there are days not falling within a complete calendar week of that year, such days shall be included (for purposes of these regulations) within the last complete calendar week of the previous year. No licensee or registrant shall change the method observed by him of determining calendar quarters for purposes of these regulations except at the beginning of a calendar year.

6. **Department** means the Montana State Department of Health acting through its Radiological Health Program.

7. **Healing Arts** means diagnostic and/or healing treatment of human and animal maladies including but not limited to the following which are duly licensed by the State of Montana for the lawful practice of: medicine and its associated specialties, dentistry, veterinary medicine, osteopathy, chiropractic, and podiatry.

8. **High Radiation Area** means any area accessible to individuals in which there exists radiation at such levels that the individual could receive in any one hour a dose to the whole body in excess of 100 millirems.

9. **Human Use** means the internal or external administration of radiation or radioactive materials.

10. **Individual** means any human being.

11. **Ionizing Radiation** (see **Radiation**).

12. **License** except where otherwise specified, means a license issued by the Department pursuant to these regulations.

13. **Licensee** means the person to whom the license is issued by the Department.

14. **Occupational Dose** means the exposure of an individual to radiation (i) in a restricted area; or (ii) in the course of employment in which the individual's duties involve exposure to radiation; provided, that occupational dose shall not be deemed to include any exposure of an individual to radiation for the purpose of medical diagnosis or medical therapy of such individual.

15. **Person** means any individual, corporation, partnership, firm, association, trust, estate, public or private institution, group, agency, political subdivision of Montana, any other state or political subdivision or agency thereof, and any legal successor, representative, agent or agency of the foregoing, other than the United States Atomic Energy Commission, or any successor thereto, and other federal government agencies licensed by the United States Atomic Energy Commission, or any successor thereto.

16. **Pharmacist** means an individual registered by this state to compound and dispense drugs, prescriptions, and poisons.

17. **Physician** means a duly licensed physician authorized to dispense drugs in the practice of medicine in Montana.

18. **Radiation** means gamma rays, x-rays, alpha and beta particles, electrons, neutrons, and other nuclear particles; but not sound or radio waves, or visible, infrared, or ultra-violet light. (Same as ionizing radiation.)

19. **Radiation Machine** means any device capable of producing radiation when the associated controls are operated, but excluding equipment which produces radation only by the use of radioactive materials.

20. **Radiation Safety Officer** means a person designated by the licensee or registrant to discharge the licensee's or registrant's radiation protection responsibilities and approval by the Department.

21. **Radioactive Material** means any material, solid, liquid, or gas which emits ionizing radition spontaneously.

22. **Registrant** means any person in Montana who registers a radiation machine/or machines with the Department in accordance with these regulations.

23. **Registration** means the filing with the Department of information concerning all radiation machines in accordance with these regulations.

24. **Research and Development** means (1) theoretical analysis, exploration, or experimentation; or (2) the extension of investigative findings and theories of a scienticic or technical nature into practical application for experimental and demonstration purposes, including the experimental production and testing of models, devices, equipment, materials, and processes.

25. **Restricted Area** means any area to which access is controlled by the licensee or registrant for purposes of protection of individuals from exposure to radiation and radioactive materials. "Restricted area" shall not include any areas used for residential quarters, although a separate room or rooms in a residential building may be set apart as a restricted area.

26. **Sealed Source** means radioactive material that is permanently bonded or fixed in a capsule or matrix designed to prevent release and dispersal of the radioactive material under the most severe conditions which are likely to be encountered in normal use and handling.

27. **Source Material** means: (1) Uranium or thorium, or any combination thereof, in any physical or chemical form or (2) ores which contain by weight one-twentieth of one percent (0.05 percent) or more of uranium, thorium or any combination thereof. Source material does not include special nuclear material.

28. **Special nuclear material in quantities not sufficient to form a critical mass:** (1) Uranium enriched in the isotope U-235 in quantities not exceeding 350 grams of contained U-235; (2) plutonium in quantities not exceeding 200 grams; (3) uranium-233 in quantities not exceeding 200 grams; (4) any combination of them in accordance with the following formula: For each kind of special nuclear material, determine the ratio between the quantity of that special nuclear material and the quantity specified above for the same kind of special nuclear material. The sum of such ratios for all of the kinds of special nuclear material in combination should not exceed "1" (i.e., unity). For example, the following quantities in combination would not exceed the limitation and are within the formula, as follows:

$$\frac{175 \text{ (grams U-235)}}{350} + \frac{50 \text{ (grams U-233)}}{200} + \frac{50 \text{ (grams Pu)}}{200} = 1$$

29. **Source of radiation** means any radioactive material, or any device or equipment emitting or capable of producing radiation.

30. **These Regulations** means Parts A, B, C, D, E, F, and G of the Radiological Health Regulations and any subsequent changes or additions thereto.

31. **Unrestricted Area** means any area to which access is not controlled by the licensee and/or registrant for purpose of

protection of individuals from exposure to radiation and radioactive materials and any area used for residential quarters.

32. **Unrefined and Unprocessed Ore** means ore in its natural form prior to any processing, such as grinding, roasting, beneficiating, or refining.

33. **Whole Body** means the whole body, or head and trunk, or active blood-forming organs, or lens of eyes, or the gonads (this definition is not applicable to the phrase "skin of the whole body").

Note: Other terms not herein specifically defined shall be used in accordance with the definitions in the Recommendations of the National Council on Radiation Protection and Measurements, or any successor thereto.

(b) Definitions of certain other words and phrases as used in these regulations are set forth in other sections, including:

(1) "Dose to the whole body" defined in Section C. 2;

(2) "Personnel monitoring equipment" defined in Section C. 10;

(3) "Radiation area" and "high radiation area" defined in Section C. 10;

(4) "Survey" defined in Section C. 9;

(5) Units of measurement of dose (rad, rem) defined in Section A. 5;

(6) Units of measurement of radioactivity defined in Section A. 6

Sec. A. 5 Units of Radiation Dose

(a) "Dose is the quantity of radiation absorbed, per unit of mass, by the body or by any portion of the body. When these regulations specify a dose during a period of time, the dose means the total quantity of radiation absorbed, per unit of mass, by the body or by any portion of the body during such period of time. Several different units of dose are in current use. Definitions of units as used in these regulations are set forth in paragraphs (b) and (c) of this section.

(b) The rad is a measure of the dose of any radiation to body tissues in terms of the energy absorbed per unit mass of the tissue. One rad is the dose corresponding to the absorption of 100 ergs per gram of tissue. (One millirad (mrad) = 0.001 rad.)

(c) The rem is a measure of the dose of any radiation to body tissue in terms of its estimated biological effect relative to a dose of one roentgen (R) of X-rays. (One millirem (mrem) = 0.001 rem.) The relation of the rem to other dose units depends upon the biological effect under consideration and upon the conditions of irradiation. For the purposes of these regulations any of the following is considered to be equivalent to a dose of one rem:

(1) A dose of 1 R due to X–, or gamma radiation;

(2) A dose of 1 rad due to X–, gamma, or beta radiation;

(3) A dose of 0.1 rad due to neutrons or high energy protons;

(4) A dose of 0.05 rad due to particles heavier than protons and with sufficient energy to reach the lens of the eye. If it is more convenient to measure the neutron flux, or equivalent, than to determine the neutron dose in rads, as provided in subparagraph (3) of this paragraph, one rem of neutron radiation may, for purposes of these regulations, be assumed to be equivalent to 14 million neutrons per square centimeter incident upon the body; or, if there exists sufficient information to estimate with reasonable accuracy the approximate distribution in energy of the neutrons, the incident number of neutrons per square centimeter equivalent to one rem may be estimated from the following table:

Neutron Flux Dose Equivalents

Neutron Energy (Mev)	Number of neutrons per square centimeter equivalent to a dose of 1 rem (neutrons/cm^2)	Average flux to deliver 100 millirem in 40 hrs. (neutrons/cm^2 per sec.)
Thermal	970×10^6	670
0.0001	720×10^6	500
0.005	820×10^6	570
0.02	400×10^6	280
0.1	120×10^6	80
0.5	43×10^6	30
1.0	26×10^6	18
2.5	29×10^6	20
5.0	26×10^6	18
7.5	24×10^6	17
10.0	24×10^6	17
10 to 30	14×10^6	10

(d) For determining the doses specified in Sections C. 2 and C. 5 (a), a dose from X– or gamma rays up to 3 Mev may be assumed to be equivalent to the exposure measured by a properly calibrated appropriate instrument in air at or near the body surface in the region of highest dose rate.

Sec. A. 6 Units of Radioactivity

(a) Radioactivity shall be measured in terms of curies. A curie is that quantity of radioactive material which decays at the rate of 3.7×10^{10} disintegrations per second or 2.2×10^{12} disintegrations per minute, except as provided in paragraph (c) of this section. A commonly used submultiple of the curie is the microcurie (u Ci). One uc=0.000001 Ci=3.7×10^4 dps=2.2×10^6 dpm.

(b) For purposes of these regulations, it may be assumed that the daughter activity concentrations in the following table are equivalent to an air concentration of 10^{-7} microcuries of Radon-222 per milliliter of air in equilibrium with the daughters RaA, RaB, RaC, and RaC':

Maximum Time Between Collection and Measurement (hours) a/	Alpha-Emitting Daughter Activity Collected Per Milliliter of Air	
	Microcuries/ml	Total alpha disintegrations per minute per ml.
0.5	7.2×10^{-8}	0.16
1.0	4.5×10^{-8}	0.10
2.0	1.3×10^{-8}	0.028
3.0	0.3×10^{-8}	0.0072

a/The duration of sample collection and the duration of measurement should be sufficiently short compared to the time between collection and measurement, as not to have a statistically significant effect upon the results.

(c) **Natural Uranium and Natural Thorium.**

(1) For the purpose of these regulations, one curie of natural uranium (U-natural in Appendix A or B of Part C) means the sum of 3.7×10^{10} disintegrations per second from U-238 plus 3.7×10^{10} dps from U-234 plus 9×10^8 dps from U-235. Also, a curie of natural thorium (Th-natural in Appendix A or B of Part C) means the sum of 3.7×10^{10} dps from Th-232 plus 3.7×10^{10} dps from Th-228.

(2) For the purpose of these regulations, one curie of natural uranium (U-natural in Appendix A or B of Part C) is equivalent to 3,000 kilograms, or 6,615 pounds of natural uranium; and one curie of natural thorium (Th-natural in Appendix A or B of Part C) is equivalent to 9,000 kilograms or 19,850 pounds of natural thorium.

Sec. A. 7 Violations An injunction or other restraining court order may be obtained by the Department prohibiting any violation of any provision of the Act or any regulation or order issued thereunder. Any person who violates any provision of the Act or any regulation or order issued thereunder and upon conviction, may be punished by fine or imprisonment or both, as provided by law.

Sec. A. 8 Impounding In the event that an emergency exists affecting the public health and safety, the Department has the authority to impound or order the impounding of sources of radiation possessed by persons who are not equipped to observe or fail to observe the provisions of the Act or these regulations.

Sec. A. 9 Additional Requirements The Department may, by rule, regulation, or order, impose upon any licensee and/or registrant such requirements in addition to those established in these regulations as it deems appropriate or necessary to minimize hazards to public health, safety, and welfare.

Sec. A. 10 Application for Exemptions The Department may, upon application by any person or upon its own initiative, grant such exemptions from the requirements of these regulations as it determines are authorized by law and will not be inimical to the public health, safety, and welfare.

Sec. A. 11 Prohibited Use

(a) The use of fluoroscopes for the purpose of fitting shoes for the public is prohibited.

(b) Hand-held fluoroscopic screens shall not be used.

Sec. A. 12 Communication All communications and reports concerning these regulations and applications filed thereunder, should be addressed to the Department of Health, Radiological Health Program, Cogswell Building, Helena, Montana 59601.

PART B

LICENSING AND REGISTRATION

Sec. B. 1 Purpose. This part provides for the licensing and registration of sources of radiation.

Sec. B. 2 Scope. No person shall receive, possess, use, transfer, own, or acquire radioactive material except as authorized in a specific or general license issued pursuant to this part or as otherwise provided in this part. All other sources of radiation, unless exempt from this part under Sections B. 3, B. 4, B. 5, B. 6, B. 7, or B. 60 shall be registered with the Department in accordance with the requirements of Section B. 60 of this part.

EXEMPTIONS

Sec. B. 3 Source Material.

(a) Any person is exempt from this part to the extent that such person receives, possesses, uses, or transfers source material in any chemical mixture, compound, solution, or alloy in which the source material is by weight less than 1/20 of 1 percent (0.05 percent) of the mixture, compound, solution, or alloy.

(b) Any person is exempt from this part to the extent that such person receives, possesses, uses, or transfers unrefined and unprocessed ore containing source material; provided that, except as authorized in a specific license, such person shall not refine or process such ore.

(c) Any person is exempt from this part to the extent that such person receives, possesses, uses, or transfers:

(1) Any quantities of thorium contained in (i) incandescent gas mantles, (ii) vacuum tubes, (iii) welding rods, (iv) electric lamps for illuminating purposes provided that each lamp does not contain more than 50 milligrams of thorium, (v) germicidal lamps, sunlamps, and lamps for outdoor or industrial lighting provided that each lamp does not contain more than 2 grams of thorium, or (vi) rare earth metals and compounds, mixtures, and products containing not more than 0.25% by weight thorium, uranium, or any combination of these.

(2) Source material contained in the following products: (i) glazed ceramic tableware, provided that the glaze contains not more than 20 percent by weight source material; (ii) glassware, glass enamel and glass enamel frit containing

not more than 10 percent by weight source material; but not including commercially manufactured glass brick, pane glass, ceramic tile or other glass, glass enamel or ceramic used in construction.

(3) Photographic film, negatives, and prints containing uranium or thorium.

(4) Any finished product or part fabricated of, or containing, tungsten or magnesium-thorium alloys; provided that the thorium content of the alloy does not exceed 4 percent by weight and that the exemption contained in this paragraph shall not be deemed to authorize the chemical, physical, or metallurgical treatment or processing of any such product or part.

(5) Uranium contained in counterweights installed in aircraft, rockets, projectiles, or missiles, or stored or handled in connection with installation or removal of such counterweights when: (i) the counterweights are manufactured in accordance with the specifications contained in a specific license or equivalent licensing document issued by the Department, the U. S. Atomic Energy Commission, or any agreement state authorizing distribution by the licensee pursuant to this subparagraph or equivalent provisions of the regulations of the AEC or any agreement state; (ii) each counterweight has been impressed with the following legend clearly legible through any plating or other covering: "CAUTION—RADIOACTIVE MATERIAL—URANIUM"; and (iii) the plating or other covering has not been removed or penetrated.

(6) Uranium used as shielding constituting part of any shipping container which is conspicuously and legibly impressed with the legend "CAUTION—RADIOACTIVE SHIELDING—URANIUM" and which meets the specifications for containers for radioactive materials prescribed by Section 178.250, Specification 55, Part 178, of the regulations published by the U. S. Department of Transportation (49 C.F.R. 178.250).

(7) Thorium contained in finished optical lenses, provided that each lens does not contain more than 30 percent by weight of thorium; and that the exemption contained in this subparagraph shall not be deemed to authorize either: (i) the shaping, grinding, or polishing of such lens or manufacturing processes other than the assembly of such lens into optical systems and devices without any alteration of the lens, or, (ii) the receipt, possession, use, or transfer of thorium contained in contact lenses, or in spectacles, or in eye glasses in binoculars or other optical instruments.

(8) Uranium contained in detector heads for use in fire detection units, provided that each detector head contains not more than 0.005 microcurie of uranium.

(9) Thorium contained in any finished aircraft engine part containing nickel-thoria alloy, provided that: (i) the thorium is dispersed in the nickel-thoria alloy in the form of finely divided thoria (thorium dioxide); and (ii) the thorium content in the nickel-thoria alloy does not exceed 4 percent by weight.

(d) The exemptions in paragraph (c) do not authorize the manufacture of any of the products described.

Sec. B. 4 Radioactive Materials.

(a) Exempt Concentrations.

(1) Except as provided in paragraph B. 4 (a) (2) below, any person is exempt from this part to the extent that such person receives, possesses, uses, transfers, owns, or acquires products or materials containing radioactive material in concentrations not in excess of those listed in Schedule C.

(2) No person may introduce radioactive material into a product or material knowing or having reason to believe that it will be transferred to persons exempt under paragraph B. 4 (a) (1) or equivalent regulations of the U. S. Atomic Energy Commission or any agreement state, except in accordance with a license issued pursuant to Section B. 26 (i) or the general license provided in Section B. 90 of this part.

(b) Certain items containing tritium, promethium-147 or radium. Except for persons who apply tritium, promethium-147 or radium to, or persons who incorporate tritium, promethium-147 or radium into, following products, any person is exempt from these regulations to the extent that he receives, possesses, uses, transfers, owns or acquires the following products:*

(1) Timepieces or timepiece hands or dials containing radium or not more than the following specified quantities of radioactive material and not exceeding the following specified levels of radiation; (i) 25 millicuries of tritium per timepiece; (ii) 5 millicuries of tritium per hand; (iii) 15 millicuries of tritium per dial (bezels when used shall be considered as part of the dial); (iv) 100 microcuries of promethium-147 per watch or 200 microcuries of promethium-147 per any other timepiece; (v) 20 microcuries of promethium-147 per watch hand

---

*Authority to transfer possession or control by the manufacturer, processor, or producer of any equipment, device, commodity, or other product-containing source, byproduct, or special nuclear material, intended for use by the general public may be obtained only from the U. S. Atomic Energy Commission, Washington, D. C. 20545.

or 40 microcuries of promethium-147 per other timepiece hand; (vi) 60 microcuries of promethium-147 per watch dial or 120 microcuries of promethium-147 per other timepiece dial (bezels when used shall be considered as part of the dial); (vii) the levels of radiation from hands and dials containing promethium-147 will not exceed, when measured through 50 milligrams per square centimeter of absorber; (a) for wrist watches, 0.1 millirad per hour at 10 centimeters from any surface; (b) for pocket watches, 0.1 millirad per hour at 1 centimeter from any surface; (c) for any other timepiece, 0.2 millirad per hour at 10 centimeters from any surface.

(2) Lock illuminators containing not more than 15 millicuries of tritium or not more than 2 millicuries of promethium-147 installed in automobile locks. The levels of radiation from each lock illuminator containing promethium-147 will not exceed 1 millirad per hour at 1 centimeter from any surface when measured through 50 milligrams per square centimeter of absorber.

(3) Balances of precision containing not more than 1 millicurie of tritium per balance or not more than 0.5 millicurie of tritium per balance part.

(4) Automobile shift quadrants containing not more than 25 millicuries of tritium.

(5) Marine compasses containing not more than 750 millicuries of tritium gas and other marine navigational instruments containing not more than 250 millicuries of tritium gas.

(6) Thermostat dials and pointers containing not more than 25 millicuries of tritium per thermostat.

(7) Glow lamps containing not more than 10 microcuries of tritium per lamp.

(8) Spark-gap tubes containing not more than 30 microcuries of promethium-147. The levels of radiation from each spark-gap tube containing promethium-147 will not exceed 0.5 millirad per hour at one centimeter from any surface when measured through 7 milligrams per square centimeter of absorber.

(c) Resins containing scandium-46 and designed for sand consolidation in oil wells. Any person is exempt from these regulations to the extent that such person receives, possesses, uses, transfers, owns or acquires synthetic plastic resins containing scandium-46 which are designed for sand consolidation in oil wells. Such resins shall have been manufactured or imported in accordance with a specific license issued by the U. S. Atomic Energy Commission, or shall have been manufactured in accordance with the specifications contained in a specific license or equivalent licensing document issued by the Department or any agreement state to the manufacturer of such resins pursuant to licensing requirements equivalent to those in Section 32.16 and 32.17 of 10 C.F.R. Part 32 of the regulations of the Atomic Energy Commission. This exemption does not authorize the manufacture of any resins containing scandium-46.

Sec. B. 5 Carriers. Common and contract carriers operating within this State are exempt from this part to the extent that they transport or store sources of radiation in the regular course of their carriage for another or storage incident thereto; PROVIDED that radioactive materials handled by such carriers have been packaged according to Sec. B. 100 (b) of these regulations.

Sec. B. 6 U. S. Atomic Energy Commission Contractors. Any U. S. Atomic Energy Commission contractor or subcontractor of the following categories operating within this State is exempt from this part to the extent that such contractor or subcontractor under his contract receives, possesses, uses, transfers, owns or acquires sources of radiation:

(a) Prime contractors performing work for the AEC at U. S. Government-owned or controlled sites;

(b) Prime contractors performing research in, or development, manufacture, storage, testing or transportation of, atomic weapons or components thereof;

(c) Prime contractors using or operating nuclear reactors or other nuclear devices in a U. S. Government-owned vehicle or vessel; and,

(d) Any other prime contractor or subcontractor when the State and the AEC jointly determine (i) that, under the terms of the contract, there is adequate assurance that the work thereunder can be accomplished without undue risk to the public health and safety and (ii) that, the exemption of such contractor or subcontractor is otherwise appropriate.

Sec. B. 7 Other Exemptions. The following machines and equipment are exempt from this part:

(a) Domestic television receivers, providing the dose rate at 5 cm from any outer surface is less than 0.5 mrem per hour.

(b) Other electrical equipment that produces radiation incidental to its operation for other purposes, providing the dose rate to the whole body at the point of nearest approach to such equipment when any external shielding is removed does not exceed 0.5 rem per year. The production testing or factory servicing of such equipment shall not be exempt.

(c) Radiation-producing machines while in transit or storage incident thereto.

LICENSES

Sec. B. 20 Types of Licenses. Licenses for radioactive materials are of two types: general and specific. General licenses provided in this part are effective without the filing of applications with the Department or the issuance of licensing documents to particular persons. Specific licenses are issued to named persons upon applications filed pursuant to this part.

Sec. B. 21 General Licenses—Source Material.

(a) A general license is hereby issued authorizing use and transfer of not more than fifteen (15) pounds of source material at any one time by persons in the following categories:

(1) Pharmacists using the source material solely for the compounding of medicinals;

(2) Physicians using the source material for medicinal purpose;

(3) Persons receiving possession of source material from pharmacists and physicians in the form of medicinals or drugs;

(4) Commercial and industrial firms, and research, educational, and medical institutions for research, development, educational, or commercial purposes;
And provided, that no such person shall, pursuant to this general license, receive more than a total of 150 pounds of source material in any one calendar year.

(b) Persons who receive, possess, use, or transfer source material pursuant to the general license issued in paragraph (a) of this section are exempt from the provisions of Part C of these regulations to the extent that such receipt, possession, use, or transfer is within the terms of such general license; provided, however, that this exemption shall not be deemed to apply to any such person who is also in possession of source material under a specific license issued pursuant to this part.

(c) A general license is hereby issued authorizing the receipt of title to source material without regard to quantity. The general license under this paragraph does not authorize any persons to receive, possess, use, or transfer source material.

Sec. B. 22 General Licenses—Radioactive Material Other Than **Source** Material.

(a) Scheduled Items and Generally Licensed Quantities
A general license is hereby issued:

(1) To transfer, receive, acquire, own, possess, and use radioactive material incorporated in a device or equipment which is listed in Schedule A and has been manufactured pursuant to a specific license or equivalent licensing document, issued by the Department, the U. S. Atomic Energy Commission, or any agreement state, and authorizing distribution under the general license of this subparagraph or its equivalent; and,

(2) To transfer, receive, acquire, own, possess, and use quantities of radioactive material listed in Schedule B, provided that no person shall at any one time possess, or use, pursuant to the general licensing provisions of this subparagraph, more than a total of ten such scheduled quantities.

(b) The general license provided in paragraph (a) is subject to the provisions of Sections A.7, A8., A.9, B.4(a)(2), B.31, B.40, B.50, B.70, B.71, B.72, B.100 and Part C*, of these regulations. In addition, persons who transfer, receive, acquire, own, possess, or use scheduled items or quantities of radioactive material pursuant to the general licenses provided in paragraph (a) of this section:

(1) Shall not effect an increase in the radioactivity of said scheduled items or quantities by adding other radioactive material thereto, by combining radioactive material from two or more such items or quantities, or by altering them in any other manner so as to increase thereby the rate of radiation therefrom;

(2) Shall not administer externally or internally, or direct the administration of, said scheduled items or quantities or any part thereof to a human being for any purpose, including, but not limited to ,diagnostic, therapeutic, and research purposes;

(3) Shall not add, or direct the addition of, said scheduled items or quantities or any part thereof to any food, beverage, cosmetic, drug, or other product designed for ingestion or inhalation by, or application to, a human being; and,

(4) Shall not include said scheduled items or quantities or any part thereof in any device, instrument, or apparatus (includ-

---

*Attention is directed particularly to the provisions of Part C of these regulations which relate to the labeling of containers.

ing component parts and accessories thereto) intended for use in diagnosis, treatment, or prevention of disease in human beings or animals or otherwise intended to affect the structure or any function of the body of human beings or animals.

(c) Certain Measuring, Gauging or Controlling Devices.

(1) A general license is hereby issued to own, receive, acquire, possess, and use radioactive material when contained in devices designed and manufactured for the purpose of detecting, measuring, gauging, or controlling thickness, density, level, interface location, radiation leakage, or qualitative or quantitative chemical composition, or for producing lights or an ionized atmosphere, when such devices are manufactured in accordance with the specifications contained in a specific license or equivalent licensing document issued to the supplier pursuant to Section B.26 (f) or its equivalent by the Department, the U. S. Atomic Energy Commission, or any agreement state, and authorizing distribution under the general license of this subparagraph or its equivalent; provided, that:

(i) Such devices are labeled in accordance with the provisions of the specific license or equivalent licensing document which authorizes the distribution of the devices;

(ii) Such devices bear a label containing the following or a substantially similar statement which contains the information called for in the following statement:

The receipt, possession, use, and transfer of this device, Model *____________, Serial No. *____________, are subject to a general license or the equivalent and the regulations of the U. S. AEC or of a State with which the AEC has entered into an agreement for the exercise of regulatory authority. Removal of this label is prohibited.

CAUTION—RADIOACTIVE MATERIAL

____

(Name of Supplier)*

*The model, serial number, and name of supplier may be omitted from this label provided they are elsewhere specified in labeling affixed to the device.

(iii) Such devices are installed on the premises of the general licensee by a person authorized to install such devices under a specific license or equivalent licensing document issued to the installer by the Department, the

U. S. Atomic Energy Commission or any agreement state, if a label affixed to the device at the time of receipt states that installation by a specific licensee is required. The requirement of this paragraph does not apply while devices are held in storage in the original shipping container pending installation by a specific licensee.

(2) Persons who own, receive, acquire, possess, or use a device pursuant to the general license contained in subparagraph (1) of this paragraph:

(i) Shall not transfer, abandon, or dispose of the device except by transfer to a person duly authorized to receive such device by a specific license or equivalent licensing document issued by the Department, the U. S. Atomic Energy Commission, or any agreement state, and shall furnish to the Department, within 30 days after any transfer, a report containing the name of the manufacturer of the device, the type of device, the manufacturer's serial number of the device, and the name and address of the person receiving the device;

(ii) Shall assure that all labels affixed to the device at the time of receipt and bearing the statement, "Removal of this label is prohibited" are maintained thereon and shall comply with all instructions contained in such labels;

(iii) Shall have the device tested for leakage of radioactive material and proper operation of the on-off mechanism and indicator, if any, at the time of installation of the device or replacement of the radioactive material on the premises of the general licensee and thereafter at no longer than six-month intervals or at such longer intervals not to exceed three years as are specified in the label required by subparagraph (c) (1) (i) of this section; provided, that devices containing only krypton need not be tested for leakage, and devices containing only tritium need not be tested for any purpose;

(iv) Shall have the tests required by subdivision (iii) of this subparagraph and all other services involving the radioactive material, its shielding and containment, performed by the supplier or other person duly authorized by a specific license or equivalent licensing document issued by the Department, the U. S. Atomic Energy Commission, or any agreement state, to manufacture, install, or service such devices;

(v) Shall, within 30 days after the occurrence of a failure of or damage to the shielding of the radioactive material or the on-off mechanism or indicator or upon the detection of 0.005 microcurie or more of removable radioactive material, furnish to the Department a report containing the name of the manufacturer of the device, the type of device, the manufacturer's serial number of the device and a brief description of the event and the remedial action taken; and shall maintain records of all tests performed on the devices as required under this section, including the dates and results of the tests and the names of the persons conducting the tests;

(vi) Shall, upon the occurrence of a failure of or damage to, or any indication of a possible failure of or damage to, the shielding or containment of the radioactive material or the on-off mechanism or indicator, immediately suspend operation of the device until it has been repaired by a person holding a specific license or equivalent licensing document issued by the Department, the U. S. Atomic Energy Commission, or any agreement state, to manufacture, install, or service such devices, or disposal of by transfer to a person holding a specific license or equivalent licensing document issued by the Department, the U. S. Atomic Energy Commission, or any agreement state to receive the radioactive material contained in the device;

(vii) Shall be exempt from the requirements of Part C of these regulations except that such persons shall comply with the provisions of Sections C.21 and C.22; and,

(viii) Shall within ten (10) days after the receipt of the device notify the Department of the type of device and the name and address of the supplier.

(3) The general license provided in subparagraph (1) of this paragraph is subject to the provisions of Sections A.7, A.8, A.9, B.31, B.40, B.50, B.70, B.71, B.72, and B.100.

(d) Luminous Safety Devices for Aircraft.

(1) A general license is hereby issued to own, receive, acquire, possess, and use tritium or promethium-147 contained in luminous safety devices for use in aircraft, provided:

(i) Each device contains not more than 10 curies of tritium or 100 millicuries of promethium-147; and,

(ii) Each device has been manufactured, assembled or imported in accordance with a specific license issued by the U. S. Atomic Energy Commission, or each device has been manufactured or assembled in accordance with the specifications contained in a specific license or equivalent licensing document issued by the Department or any agreement state to the manufacturer or assembler of such device pursuant to licensing requirements equivalent to those in Section 32.53 of 10 C.F.R. Part 32 of the regulations of the U. S. Atomic Energy Commission.

(2) Persons who own, receive, acquire, possess, or use luminous safety devices pursuant to the general license in subparagraph (1) of this paragraph are exempt from the requirements of Part C except that they shall comply with the provisions of Sections C.21 and C.22.

(3) This general license does not authorize the manufacture, assembly or repair of luminous safety devices containing tritium or promethium-147.

(4) This general license does not authorize the ownership, receipt, acquisition, possession or use of promethium-147 contained in instrument dials.

(5) The general license provided in this paragraph is subject to the provisions of Sections A.7, A.8, A.9, B.31, B.40, B.50, B.70, B.71, B.72 and B.100.

(e) Calibration and Reference Sources.

(1) A general license is hereby issued to those persons listed below to own, receive, acquire, possess, use, and transfer, in accordance with the provisions of subparagraphs (3) and (4) of this paragraph (e), americium-241 in the form of calibration or reference sources;

(i) Any person who holds a specific license issued by the Department which authorizes him to receive, possess, use, and transfer radioactive material; and,

(ii) Any person who holds a specific license issued by the U. S. Atomic Energy Commission which authorizes him to receive, possess, use, and transfer special nuclear material.

(2) A general license is hereby issued to receive, possess, use, and transfer plutonium in the form of calibration or reference sources in accordance with the provisions of subparagraphs (3) and (4) of this paragraph (e) to any person who

holds a specific license issued by the Department which authorizes him to receive, possess, use, and transfer radioactive material.

(3) The general licenses in subparagraphs (1) and (2) of this paragraph apply only to calibration or reference sources which have been manufactured in accordance with the specifications contained in a specific license issued to the manufacturer or importer of the sources by the U. S. Atomic Energy Commission pursuant to Section 32.57 of 10 C.F.R. Part 32 or Section 70.39 of 10 C.F.R. Part 70 or which have been manufactured in accordance with the specifications contained in a specific license or equivalent licensing document issued to the manufacturer by the Department or any agreement state pursuant to licensing requirements equivalent to those contained in Section 32.57 of 10 C.F.R. Part 32 or Section 70.39 of 10 C.F.R. Part 70 of the regulations of the U. S. Atomic Energy Commission.

(4) The general licenses provided in subparagraphs (1) and (2) of this paragraph are subject to the provisions of Sections A.7, A.8, A.9, B.31, B.40, B.50, B.70, B.71, B.72, B.100 and Part C of these regulations. In addition, persons who own, receive, acquire, possess, use, and transfer one or more calibration or reference sources pursuant to these general licenses:

(i) Shall not possess at any one time, at any one location of storage or use, more than 5 microcuries of americium-241 and 5 microcuries of plutonium in such sources;

(ii) Shall not receive, possess, use, or transfer such source unless the source, or the storage container, bears the label which includes the following statement or a substantially similar statement which contains the information called for in the following statement: The receipt, possession, use and transfer of this source, Model __________, Serial No.__________, are subject to a general license and the regulations of the U. S. Atomic Energy Commission or of a State with which the Commission has entered into an agreement for the exercise of regulatory authority. Do not remove this label.

CAUTION—RADIOACTIVE MATERIAL—THIS SOURCE CONTAINS (AMERICIUM-241). (PLUTONIUM)[*] DO NOT TOUCH RADIOACTIVE PORTION OF THIS SOURCE.

(Name of Manufacturer or Importer)

---

[*] **Showing only the name of the appropriate material.**

(iii) Shall not transfer, abandon, or dispose of such source except by transfer to a person authorized by a license from the Department, the U. S. Atomic Energy Commission, or an agreement state to receive the source;

(iv) Shall store such source, except when the source is being used, in a closed container adequately designed and constructed to contain americium-241 or plutonium which might otherwise escape during storage; and,

(v) Shall not use such source for any purpose other than the calibration of radiation detectors or the standardization of other sources.

(5) These general licenses do not authorize the manufacture of calibration or reference sources containing americium-241 or plutonium.

(f) Ownership of radioactive material. A general license is hereby issued to own radioactive material without regard to quantity. Notwithstanding any other provisions of this part, this general license does not authorize the manufacture, production, transfer, receipt, possession or use of radioactive material.

(g) Medical Diagnostic Uses.

(1) A general license is hereby issued to any physician to receive, possess, transfer, or use for any of the following stated diagnostic uses, and others as approved by AEC, in accordance with the provisions of subparagraphs (2), (3), and (4) of this paragraph, the following radioactive materials in capsules, disposable syringes or other forms of prepackaged individual doses;*

(i) Iodine-131 as sodium iodide (NaI^{131}) for measurement of thyroid uptake;

(ii) Iodine-131 as iodinated human serum albumin (IHSA) for determination of blood and blood plasma volume;

(iii) Iodine-125 as iodinated human serum albumin (IHSA) for determination of blood and blood plasma volume;

(iv) Cobalt-57 for the measurement of intestinal absorption of cyanocobalamin.

(v) Cobalt-58 for the measurement of intestinal absorption of cyanocobalamin;

---

* Subsection B.26 (i) requires manufacturers of radiopharmaceuticals which are under the general license in this paragraph to affix a certain identifying label to the containers, or in the leaflet or brochure which accompanies the radiopharmaceutical.

(vi) Cobalt-60 for the measurement of intestinal absorption of cyanocobalamin;

(vii) Chromium-51 as sodium radiochromate for determination of red blood cell volumes and studies of red blood cell survival time.

(2) No physician shall receive, possess, use, or transfer radioactive material pursuant to the general license established by subparagraph (1) of this paragraph until he has provided the Department with the following information and has received from the Department written permission to enter into the aforementioned activities.

(i) Name and address of the generally licensed physician;

(ii) A statement that the generally licensed physician is a duly licensed physician authorized to dispense drugs in the practice of medicine in this state; and

(iii) A statement that the generally licensed physician has appropriate radiation measuring instruments to carry out the diagnostic procedures for which he proposes to use radioactive material under the general license of B.22 (g) and that he is competent in the use of such instruments.

(3) A physician who receives, possesses, or uses a pharmaceutical containing radioactive material pursuant to the general license established by subparagraph (1) of this paragraph shall comply with the following:

(i) He shall not possess at any one time, pursuant to the general license in subparagraph (1) of this paragraph, more than:

(a) 200 microcuries of iodine-131,

(b) 200 microcuries of iodine-125,

(c) 5 microcuries of cobalt-57,

(d) 5 microcuries of cobalt-58,

(e) 5 microcuries of cobalt-60, and

(f) 200 microcuries of chromium-51;

(ii) He shall store the pharmaceutical until administered in the original shipping container, or in a container providing equivalent radiation protection;

(iii) He shall use the pharmaceutical only for the uses authorized by subparagraph (1) of this paragraph;

(iv) He shall not administer the pharmaceutical to a woman with confirmed pregnancy or to a person under 18 years of age; and,

(v) He shall not transfer the radioactive material to a person who is not authorized to receive it pursuant to a license issued by the Department, the U. S. Atomic Energy Commission or any agreement state, or in any manner other than in the unopened, labeled shipping container as received from the supplier, except by administering it to a patient.

(4) The generally licensed physician possessing or using radioactive material under the general license of subparagraph (1) shall report to the Department any changes in information furnished by him to the Department under subparagraph (2). This report will be submitted within 30 days after the effective date of such change.

(5) Any person using radioactive material pursuant to the general license of subparagraph (1) of this paragraph is exempt from the requirements of Part C of these regulations with respect to the radioactive materials covered by the general license.

(h) Ice Detection Devices.

(1) A general license is hereby issued to own, receive, acquire, possess, use, and transfer strontium-90 contained in ice detection devices, provided each device contains not more than fifty microcuries of strontium-90 and each device has been manufactured or imported in accordance with a specific license issued by the U. S. Atomic Energy Commission or each device has been manufactured in accordance with the specifications contained in a specific license or equivalent licensing document issued by the Department or any agreement state to the manufacturer of such device pursuant to licensing requirements equivalent to those in Section 32.61 of 10 C.F.R. Part 32 of the regulations of the Atomic Energy Commission.

(2) Persons who own, receive, acquire, possess, use, or transfer strontium-90 contained in ice detection devices pursuant to the general license in subparagraph (1) of this paragraph (h):

(i) Shall, upon occurrence of visually observable damage, such as a bend or crack or discoloration from overheating, to the device, discontinue use of the device until it has been inspected, tested for leakage and repaired by a person holding a specific license or equivalent document from the Department, U. S. Atomic Energy Commission or an agreement state to manufacture or service such devices; or shall dispose of the device pursuant to the provisions of this regulation;

(ii) Shall assure that all labels affixed to the device at the time of receipt, and which bear a statement which prohibits removal of the labels, are maintained thereon; and

(iii) Are exempt from the requirements of Part C except that such persons shall comply with the provisions of Sections C.15, C.21 and C.22 of these regulations.

(3) This general license does not authorize the manufacture, assembly, disassembly or repair of strontium-90 in ice detection devices.

(4) The general license provided in this paragraph is subject to the provisions of Sections A.7, A.8, A.9, B.31, B.40, B.50, B.70, B.71, B.72, and B.100.

(i) General License for Use of Iodine-125 or Iodine-131 For In Vitro Clinical or Laboratory Testing.

(1) A general license is hereby issued to any physician, clinical laboratory or hospital to receive, acquire, possess, transfer or use, for any of the following stated tests, in accordance with the provisions of subparagraphs (2), (3), (4), (5), and (6) of this paragraph, the following radioactive materials in prepackaged units:

(i) Iodine-125, in units not exceeding 10 microcuries each for use in **in vitro** clinical or laboratory tests not involving internal or external administration of radioactive material, or the radiation therefrom, to human beings or animals.

(ii) Iodine-131, in units not exceeding 10 microcuries each for use in **in vitro** clinical or laboratory tests not involving internal or external administration of radioactive material, or the radiation therefrom, to human beings or animals.

(2) No person shall receive, acquire, possess, use or transfer radioactive material pursuant to the general license established by subparagraph (1) of this paragraph until he has requested and received written permission from the Department. The physician, clinical laboratory or hospital shall

furnish on this request to the Department the following information and any such other information as requested by the Department:

(i) Name and address of the physician, clinical laboratory or hospital;

(ii) The location of use; and,

(iii) A statement that the physician, clinical laboratory or hospital has appropriate radiation measuring instruments to carry out **in vitro** clinical or laboratory tests with radioactive materials as authorized under the general license in subparagraph (1) of this paragraph and that such tests will be performed only by personnel competent in the use of such instruments and in the handling of the radioactive materials.

(3) A person who receives, acquires, possesses or uses radioactive material pursuant to the general license established by subparagraph (1) of this paragraph shall comply with the following:

(i) The general licensee shall not possess at any one time, pursuant to the general license in subparagraph (1) of this paragraph, at any one location of storage or use a total amount of iodine-125 and/or iodine-131 in excess of 200 microcuries.

(ii) The general licensee shall store the radioactive material, until used, in the original shipping container or in a container providing equivalent radiation protection.

(iii) The general licensee shall use the radioactive material only for the uses authorized by subparagraph (1) of this paragraph.

(iv) The general licensee shall not transfer the radioactive material to a person who is not authorized to receive it pursuant to a license issued by the Department, the U. S. Atomic Energy Commission, or any agreement state, nor transfer the radioactive material in any manner other than in the unopened, labeled shipping container as received from the supplier.

(4) The general licensee shall not receive, acquire, possess, or use radioactive material pursuant to subparagraph (1) of this paragraph:

(i) Except as prepackaged units which are labeled in accordance with the provisions of a specific license issued under Paragraph B.26(e) of this Part or in accordance with the provisions of a specific license issued by the U. S. Atomic Energy Commission, or any agreement state which authorizes the manufacture of iodine-125 or iodine-131 for distribution to persons generally licensed under Paragraph B.22(i) or its equivalent.

(ii) Unless the following statement, or a substantially similar statement which contains the information called for in the following statement, appears on a label affixed to each prepackaged unit or appears in a leaflet or brochure which accompanies the package:

This radioactive material may be received, acquired, possessed, and used only by physicians, clinical laboratories or hospitals and only for **in vitro** clinical or laboratory tests not involving internal or external administration of the material, or the radiation therefrom, to human beings or animals. Its receipt, acquisition, possession, use, and transfer are subject to the regulations and a general license of the United States Atomic Energy Commission or of a state with which the Commission has entered into an agreement for the exercise of regulatory authority.

____
Name of Manufacturer

(5) The physician, clinical laboratory or hospital possessing or using radioactive materials under the general license of subparagraph (1) of this paragraph shall report in writing to the Department, any changes in the information furnished by him under subparagraph (2) of this paragraph. The report shall be furnished within 30 days after the effective date of such change.

(6) Any person using radioactive material pursuant to the general license of subparagraph (1) of this paragraph is exempt from the requirements of Part C of these regulations with respect to radioactive materials covered by that general license.

SPECIFIC LICENSES

Sec. B.24 Filing of Application for Specific Licenses.

(a) Applications for specific licenses shall be filed on a form prescribed by the Department.

(b) The Department may at any time after the filing of the original application, and before the expiration of the license, require further statements in order to enable the Department to determine whether the application should be granted or denied or whether a license should be modified or revoked.

(c) Each application shall be signed by the applicant or licensee or a person duly authorized to act for and on his behalf.

(d) An application for a license may include a request for a license authorizing one or more activities.

(e) In his application, the applicant may incorporate by reference information contained in previous applications, statements, or reports filed with the Department provided such references are clear and specific.

(f) Applications and documents submitted to the Department may be made available for public inspection except that the Department may withhold any document or part thereof from public inspection if disclosure of its contents is not required in the public interest and would adversely affect the interest of a person concerned.

Sec. B.25 General Requirements for the Issuance of Specific Licenses. A license application will be approved if the Department determines that:

(a) The applicant is qualified by reason of training and experience to use the material in question for the purpose requested in accordance with these regulations in such a manner as to minimize danger to public health and safety or property; and,

(b) The applicant's proposed equipment, facilities, and procedures are adequate to minimize danger to public health and safety or property; and,

(c) The issuance of the license will not be inimical to the health and safety of the public; and,

(d) The applicant satisfies any applicable special requirements in Section B.26 or Section B.27.

Sec. B.26 Special Requirements for Issuance of Certain Specific Licenses for Radioactive Materials.

(a) Human Use of Radioactive Materials in Institutions. In addition to the requirements set forth in Section B.25 above, a specific license for human use of radioactive material in institutions will be issued only if:

(1) The applicant has appointed a medical isotopes committee of at least three members to evaluate all proposals for re-

search, diagnostic, and therapeutic use of radioisotopes within that institution. Membership of the committee should include physicians expert in internal medicine, hematology, therapeutic radiology, and a person experienced in assay of radioisotopes and protection against radiation; and,

(2) The applicant possesses adequate facilities for the clinical care of patients; and,

(3) The physician designated on the application as the individual user has substantial experience in the handling and administration of radioisotopes and, where applicable, the clinical management of radioactive patients; and,

(4) If the application is for a license to use unspecified quantities or multiple types of radioactive material, the applicant's staff has substantial experience in the use of a variety of radioactive materials for a variety of human uses.

(b) Licensing of Individual Physicians for Human Use of Radioactive Materials. In addition to the requirements set forth in Section B.25 above, a specific license for the human use of radioactive materials will be issued to an individual physician only if:

(1) The applicant has access to a hospital possessing adequate facilities to hospitalize and monitor the applicant's radioactive patients whenever it is advisable; and,

(2) The applicant has extensive experience in the handling and administration of radioisotopes and, where applicable, the clinical management of radioactive patients.

(c) Groups of Diagnostic Uses. An application for a specific license pursuant to paragraphs (a) or (b) of this section for any diagnostic use of radioactive material specified in Group I or Group II of Schedule D (see Appendix) will be approved for all of the diagnostic uses within the group which includes the use specified in the application if:

(1) The applicant satisfies the requirements of paragraph (a) or (b);

(2) The applicant or the physician designated in the application as the individual user has adequate clinical experience in the performance of diagnostic procedures specified in the appropriate group in Schedule D; and,

(3) The applicant's proposed radiation detection instrumentation is adequate for conducting the diagnostic procedures specified in the appropriate group in Schedule D.

(d) Human Use of Sealed Sources. In addition to the requirements set forth in Section B.25 above, a specific license for human use of sealed sources will be issued only if the applicant, or if the application is made by an institution, the individual user (i) has specialized training in the therapeutic use of the sealed source considered (teletherapy unit, beta applicator, etc.) or has experience equivalent to such training, and (ii) is a physician.

(e) Distribution of Devices to Persons Generally Licensed Under Section B.22(c). In addition to the requirements set forth in Section B.25 above, a specific license to distribute certain devices of the types enumerated in Section B.22(c) to persons generally licensed under Section B.22(c) will be issued only if:

(1) The applicant submits sufficient information relating to the design, manufacture, prototype testing, quality control procedures, labeling, proposed uses, and potential hazards of the device to provide reasonable assurance that:

(i) The radioactive material contained in the device will not be lost;

(ii) No individual will receive a radiation exposure to a major portion of his body in excess of 0.5 Rem in a year under ordinary circumstances of use;

(iii) The device can be safely operated by individuals not having training in radiological protection; and,

(iv) The radioactive material within the device will not be accessible to unauthorized individuals.

(2) In describing the label or labels and contents thereon to be affixed to the device, the applicant should separately indicate those instructions and precautions which are necessary to assure safe operation of the device. Such instructions and precautions must be contained on labels bearing the statement, "Removal of this label is prohibited."

(3) In the event the applicant desires that the device be tested for proper operation of the on-off mechanism and indicator, if any, and for leakage of radioactive material, subsequent to the initial tests required by Section B.22(c) (2) (iii), at intervals longer than six months but not exceeding three years, he shall include in his application sufficient information to demonstrate that such longer interval is justified by performance characteristics of the device or similar devices, and by design features which have a significant bearing on the probability or consequences of leakage of radioactive material from the device. In determining the acceptable in-

terval for test of leakage of radioactive material, the Department will consider information on particulars which include, but are not necessarily limited to:

(i) Primary containment (source capsule);

(ii) Protection of primary containment;

(iii) Method of sealing containment;

(iv) Containment construction materials;

(v) Form of contained radioactive material;

(vi) Maximum temperature withstood during prototype tests;

(vii) Maximum pressure withstood during prototype tests;

(viii) Maximum quantity of contained radioactive material;

(ix) Radiotoxicity of contained radioactive material; and,

(x) Operating experience with identical devices or similarly designed and constructed devices.

(f) Use of Sealed Sources in Industrial Radiography*. In addition to the requirements set forth in Section B.25 above, a specific license for use of sealed sources in industrial radiography will be issued only if:

(1) The applicant will have an adequate program for training radiographers and radiographer's assistants and submits to the Department a schedule or description of such program which specifies the:

(i) Initial training;

(ii) Periodic training;

(iii) On-the-job training;

(iv) Means to be used by the licensee to determine the radiographer's knowledge and understanding of and ability to comply with Department regulations and licensing requirements, and the operating and emergency procedures of the applicant; and,

(v) Means to be used by the licensee to determine the assistant radiographer's knowledge and understanding of and ability to comply with the operating and emergency procedures of the applicant.

---

[4] **Industrial radiography for the purpose of this paragraph means the macroscopic examination of the structure of materials by nondestructive methods utilizing sealed sources of radioactive material.**

(2) The applicant has established and submits to the Department satisfactory written operating and emergency procedures as described in Section D.21; and,

(3) The applicant will have an adequate internal inspection system, or other management control, to assure that license provisions, regulations, and the applicant's operating and emergency procedures are followed by radiographers and assistant radiographers; and,

(4) The applicant submits to the Department a description of his overall organizational structure pertaining to the industrial radiography program, including specified delegations of authority and responsibility for operation of the program; and,

(5) The applicant who desires to conduct his own leak tests has established adequate procedures to be followed in leak testing sealed sources for possible leakage and contamination and submits to the Department a description of such procedures including:

(i) Instrumentation to be used;

(ii) Method of performing test, e.g., points on equipment to be smeared and method of taking smear; and,

(iii) Pertinent experience of the person who will perform the test.

(g) Licensing the Introduction of Radioactive Material into Products in Exempt Concentrations. In addition to the requirements set forth in Section B.25 above, a specific license authorizing the introduction of radioactive material into a product or material owned by or in the possession of the licensee or another to be transfered to persons exempt under paragraph B.4(a) (1) will be issued only if:

(1) The applicant submits a description of the product or material into which the radioactive material will be introduced, intended use of the radioactive material and the product or material into which it is introduced, method of introduction, initial concentration of the radioactive material in the product or material, control methods to assure that no more than the specified concentration is introduced into the product or material, estimated time interval between introduction and transfer of the product or material, and estimated concentration of the radioactive material in the product or material at the time of transfer; and,

(2) The applicant provides reasonable assurance that the concentrations of radioactive material at the time of transfer will not exceed the concentrations in Schedule C, that reconcentration of the radioactive material in concentrations exceeding those in Schedule C is not likely, that use of lower concentrations is not feasible, and that the product or material is not likely to be incorporated in any food, beverage, cosmetic, drug or other commodity or product designed for ingestion or inhalation by, or application to, a human being. Each person licensed under this paragraph (g) shall file an annual report with the Department describing the type and quantity of each product or material into which radioactive material has been introduced during the reporting period, name and address of the person who owns or possesses the product or material into which radioactive material has been introduced, the type and quantity of radioactive material introduced into each such product or material, and the initial concentrations of radioactive material in the product or material at time of transfer of the radioactive material by the licensee. The report shall be submitted within 30 days after the end of each calendar year in which the licensee introduces radioactive material into a product or material pursuant to a license granted under this paragraph.

(h) Manufacture and Distribution of Radioactive Material for Medical Use Under General License. In addition to requirements set forth in Section B.25 above, a specific license authorizing the distribution of radioactive material for use by physicians under the general license in paragraph B.22 (f) will be issued only if:

(1) The applicant submits evidence that the radioactive material is to be manufactured, labeled, and packaged in accordance with a new drug application which the Commissioner of Food and Drug Administration, has approved, or in accordance with a license for a biologic product issued by the Secretary, Department of Health, Education, and Welfare; and,

(2) The following statement, or a substantially similar statement which contains the information called for in the following statement, appears on the label affixed to the container or appears in the leaflet or brochure which accompanies the package: "This radioactive drug may be received, possessed, and used only by physicians licensed to dispense drugs in the practice of medicine. Its receipt, possession, use and transfer are subject to the regulations and a general license or the equivalent of the U. S. Atomic Energy

Commission or of a State with which the Commission has entered into an agreement for the exercise of regulatory authority."

(Name of Manufacturer)

(i) Manufacture and Distribution of Radioactive Materials for Certain **In Vitro** Clinical or Laboratory Testing Under General License. An application for a specific license to manufacture or distribute radioactive material for use under the general license of B.22(i) of this Part will be approved if:

(1) The applicant satisfies the general requirements specified in Section B.25 of this Part.

(2) The radioactive material is to be prepared for distribution in prepackaged units of:

(i) Iodine-125 in units not exceeding 10 microcuries each.

(ii) Iodine-131 in units not exceeding 10 microcuries each.

(3) Each prepackaged unit bears a durable, clearly visible label:

(i) Identifying the radioactive contents as to chemical form and radionuclide, and indicating that the amount of radioactivity does not exceed 10 microcuries; and,

(ii) Displaying the radiation caution symbol described in C.11(a) (1) of Part C and the words, "CAUTION, RADIOACTIVE MATERIAL", and "Not for Internal or External Use in Humans or Animals".

(4) The following statement, or a substantially similar statement which contains the information called for in the following statement, appears on a label affixed to each prepackaged unit or appears in a leaflet or brochure which accompanies the package:

"This radioactive material may be received, acquired, possessed, and used only by physicians, clinical laboratories or hospitals and only for **in-vitro** clinical or laboratory tests not involving internal or external administration of the material, or the radiation therefrom, to human beings or animals. Its receipt, acquisition, possession, use, and transfer are subject to the regulations and a general license of the United States Atomic Energy Commission or of a State with which the Commission has entered into an agreement for the exercise of regulatory authority."

(Name of Manufacturer)

(5) The label affixed to the unit, or the leaflet or brochure which accompanies the package, contains adequate information as to the precautions to be observed in handling and storing such radioactive material.

Sec. B.27 Special Requirements for Specific Licenses of Broad Scope.

(a) The different types of broad licenses are set forth below:

(1) A "Type A specific license of broad scope" is a specific license authorizing receipt, acquisition, ownership, possession, use and transfer of any chemical or physical form of the radioactive material specified in the license, but not exceeding quantities specified in the license, for any authorized purpose. The quantities specified are usually in the multicurie range.

(2) A "Type B specific license of broad scope" is a specific license authorizing receipt, acquisition, ownership, possession, use and transfer of any chemical or physical form of radioactive material specified in Schedule E, for any authorized purpose. The possession limit for a Type B broad license, if only one radionuclide is possessed thereunder, is the quantity specified for that radionuclide in Schedule E, Column I. If two or more radionuclides are possessed thereunder, the possession limit for each is determined as follows: For each radionuclide, determine the ratio of the quantity possessed to the applicable quantity specified in Schedule E, Column I, for that radionuclide. The sum of the ratios for all radionuclides possessed under the license shall not exceed unity.

(3) A "Type C specific license of broad scope" is a specific license authorizing receipt, acquisition, ownership, possession, use and transfer of any chemical or physical form of radioactive material specified in Schedule E, for any authorized purpose. The possession limit for a Type C broad license, if only one radionuclide is possessed thereunder, is the quantity specified for that radionuclide in Schedule E, Column II. If two or more radionuclides are possessed thereunder, the possession limit is determined for each as follows: For each radionuclide determine the ratio of the quantity possessed to the applicable quantity specified in Schedule E, Column II, for that radionuclide. The sum of the ratios for all radionuclides possessed under the license shall not exceed unity.

(b) An application for a Type A specific license of broad scope will be approved if:

(1) The applicant satisfies the general requirements specified in Section B.25 of this Part;

(2) The applicant has engaged in a reasonable number of activities involving the use of radioactive material; and,

(3) The applicant has established administrative controls and provisions relating to organization and management, procedures, record keeping, material control and accounting, and management review that are necessary to assure safe operations, including:

  (i) The establishment of a radiation safety committee composed of such persons as radiological safety officer, a representative of management, and persons trained and experienced in the safe use of radioactive materials;

  (ii) The appointment of a radiological safety officer who is qualified by training and experience in radiation protection, and who is available for advice and assistance on radiological safety matters; and,

  (iii) The establishment of appropriate administrative procedures to assure:

    (a) Control of procurement and use of radioactive material;

    (b) Completion of safety evaluations of proposed uses of radioactive material which take into consideration such matters as the adequacy of facilities and equipment, training and experience of the user, and the operating or handling procedures; and,

    (c) Review, approval, and recording by the radiation committee of safety evaluation of proposed uses prepared in accordance with subdivision (b) of this subparagraph (iii) prior to use of the radioactive material.

(c) An application for a Type B specific license of broad scope will be approved if:

(1) The applicant satisfies the general requirements specified in Section B.25 of this Part; and,

(2) The applicant has established administrative controls and provisions relating to organization and management, procedures, record keeping, material control and accounting, and management review that are necessary to assure safe operations, including:

(i) The appointment of a radiological safety officer who is qualified by training and experience in radiation protection, and who is available for advice and assistance on radiological safety matters; and,

(ii) The establishment of appropriate administrative procedures to assure:

(a) Control of procurement and use of radioactive material;

(b) Completion of safety evaluations of proposed uses of radioactive material which take into consideration such matters as the adequacy of facilities and equipment, training and experience of the user, and the operating or handling procedures; and,

(c) Review, approval, and recording by the radiological safety officer or safety evaluations of proposed uses prepared in accordance with subdivisions (b) of this subparagraph (ii) prior to use of the radioactive material.

(d) An application for a Type C specific license of broad scope will be approved if:

(1) The applicant satisfies the general requirements specified in Section B.25 of this Part; and,

(2) The applicant submits a statement that radioactive material will be used only by, or under the direct supervision of, individuals who have received:

(i) A college degree at the bachelor level, or equivalent training and experience, in the physical or biological sciences or in engineering; and,

(ii) At least 40 hours of training and experience in the safe handling of radioactive materials, and in the characteristics of ionizing radiation, units of radiation dose and quantities, radiation detection instrumentation, and biological hazards of exposure to radiation appropriate to the type and forms of radioactive material to be used; and,

(3) The applicant has established administrative controls and provisions relating to procurement of radioactive material, procedures, record keeping, material control and accounting, and management review necessary to assure safe operations.

(e) Specific licenses of broad scope are subject to the following conditions:

(1) Persons licensed pursuant to this Section B.27 shall not:

(i) Conduct tracer studies in the environment involving direct release of radioactive material;

(ii) Receive, acquire, own, possess, use or transfer devices containing 100,000 curies or more of radioactive material in sealed sources used for irradiation of materials;

(iii) Conduct activities for which a specific license issued by the Department under Section B.26 of this Part is required; or

(iv) Add or cause the addition of radioactive material to any food, beverage, cosmetic, drug, or other product designed for ingestion or inhalation by, or application to, a human being.

(2) Each Type A specific license of broad scope issued under this Part shall be subject to the condition that radioactive material possessed under the license may only be used by, or under the direct supervision of, individuals approved by the licensee's radiation safety committee.

(3) Each Type B specific license of broad scope issued under this Part shall be subject to the condition that radioactive material possessed under the license may only be used by, or under the direct supervision of, individuals approved by the licensee's radiological safety officer.

(4) Each Type C specific license of broad scope issued under this Part shall be subject to the condition that radioactive material possessed under the license may only be used by, or under the direct supervision of, individuals who satisfy the requirements of paragraph (d) of this Section B.27.

Sec. B.30 Issuance of Specific Licenses.

(a) Upon determination that an application meets the requirements of the Act and the regulations of the Department, the Department will issue a specific license authorizing the proposed activity in such form and containing such conditions and limitations as it deems appropriate or necessary.

(b) The Department may incorporate in any license at the time of issuance, or thereafter by appropriate rule, regulation, or order, such additional requirements and conditions with respect to the licensee's receipt, possession, use, and transfer of radioactive material subject to this Part as it deems appropriate or necessary in order to:

(1) Minimize danger to public health and safety or property;

(2) Require such reports and the keeping of such records, and to provide for such inspections of activities under the license as may be appropriate or necessary; and,

(3) Prevent loss or theft of material subject to this Part.

Sec. B.31 Specific Terms and Conditions of Licenses.

(a) Each license issued pursuant to this Part shall be subject to all the provisions of the Act, now or hereafter in effect, and to all rules, regulations, and orders of the Department.

(b) Neither the license nor any right under the license shall be assigned or otherwise transferred in violation of the provisions of the Act.

(c) Each person licensed by the Department pursuant to this Part shall confine his use and possession of the material licensed to the location and purposes authorized in the license.

(d) Each licensee authorized under Section B.26 (e) to distribute certain devices to generally licensed persons:

(1) Shall report to the Department all transfers of such devices to persons generally licensed under Section B.22 (c). Such report shall identify each general licensee by name and address, the type of device transferred, and the quantity and type of radioactive material contained in the device. The report shall be submitted within 30 days after the end of each calendar quarter in which such a device is transferred to generally licensed persons; and,

(2) Shall furnish to each general licensee in this state to whom he transfers such device a copy of the general license contained in Section B.22 (c).

Sec. B.32 Expiration of Licenses. Except as provided in Section B.33(b), each specific license shall expire at the end of the day, in the month and year stated therein.

Sec. B.33 Renewal of Licenses.

(a) Applications for renewal of specific licenses shall be filed in accordance with Section B.24.

(b) In any case in which a licensee, not less than thirty (30) days prior to expiration of his existing license, has filed an application in proper form for renewal or for a new license authorizing the same activities, such existing license shall not expire until the application has been finally acted upon by the Department, or the time for seeking judicial review has elapsed.

Sec. B.34 Amendment of Licenses at Request of Licensee. Applications for amendment of a license shall be filed in accordance with Section B.24 and shall specify the respects in which the licensee desires his license to be amended and the grounds for such amendment.

Sec. B.35 Department Action on Applications to Renew or Amend. In considering an application by a licensee to renew or amend his license, the Department will apply the criteria set forth in Sections B.25 and B.26 as applicable.

Sec. B.36 Inalienability of Licenses. No license issued or granted under this Part and no right to possess or utilize radioactive material granted by any license issued pursuant to this Part shall be transferred, assigned, or in any manner disposed of, either voluntarily or involuntarily, directly or indirectly, through transfer of control of any license to any person unless the Department shall, after securing full information find that the transfer is in accordance with the provisions of the Act, and shall give its consent in writing.

Sec. B.37 Persons Possessing a License for Source, Byproduct, or Special Nuclear Material in Quantities Not Sufficient to Form a Critical Mass on Effective Date of these Regulations. Any person who, on the effective date of these regulations, possesses a general or specific license for source, byproduct, or special nuclear material in quantities not sufficient to form a critical mass, issued by the U. S. Atomic Energy Commission, shall be deemed to possess a like license issued under this Part and the Act, such license to expire either ninety (90) days after receipt from the Department of a notice of expiration of such license, or on the date of expiration specified in the U. S. Atomic Energy Commission license, whichever is earlier.

Sec. B.38 Persons Possessing Radioactive Material Other Than Agreement Material on Effective Date of These Regulations. Any person who, on the effective date of these regulations, possesses naturally occurring or accelerator-produced radioactive material for which a specific license is required by the Act or this Part shall be deemed to possess such a license issued under this Act and this Part. Such license shall expire ninety (90) days after the effective date of these regulations; provided, however, that if within the ninety (90) days the person possessing such material files an application in proper form for a license, such existing license shall not expire until the application has been finally determined by the Department.

Sec. B.40 Transfer of Material.

(a) No licensee shall transfer radioactive material except as authorized pursuant to this section.

(b) Any licensee may transfer radioactive material:

(1) To the Department;

(2) To the U. S. Atomic Energy Commission;

(3) To any person exempt from the regulations in this Part to the extent permitted under such exemption.

(4) To any person authorized to receive such material under terms of a general license or its equivalent; or a specific license or equivalent licensing document, issued by the Department, the U. S. Atomic Energy Commission, or any agreement state, or to any person otherwise authorized to receive such material by the Department, the U. S. AEC, or any agreement state; or,

(5) As otherwise authorized by the Department in writing.

Sec. B.50 Modification, Revocation, and Termination of Licenses.

(a) The terms and conditions of all licenses shall be subject to amendment, revision, or modification, or the license may be suspended or revoked by reason of amendments to the Act, or by reason of rules, regulations, and orders issued by the Department.

(b) Any license may be revoked, suspended, or modified, in whole or in part, for any material false statement in the application or any statement of fact required under provisions of the Act, or because of conditions revealed by such application or statement of fact or any report, record, or inspection or other means which would warrant the Department to refuse to grant a license on an original application, or for violation of, or failure to observe any of the terms and conditions of the Act, or the license, or of any rule, regulation, or order of the Department.

(c) Except in cases of willfulness or those in which the public health interest, or safety requires otherwise, no license shall be modified, suspended, or revoked unless, prior to the institution of proceedings therefore, facts or conduct which may warrant such action shall have been called to the attention of the licensee in writing and the licensee shall have been accorded an opportunity to demonstrate or achieve compliance with all lawful requirements.

(d) The Department may terminate a specific license upon request, submitted by the licensee, to the Department in writing.

REGISTRATION

Sec. B.60 Registration.

(a) The owner or person having possession of any radiation machine, except those specifically exempted in Sections B.5, B.6, and B.7, shall:

(1) Register such machine with the Department within 30 days following the effective date of these regulations or after acquisition of such machine and prior to its use. Registration shall be on forms available from the Department.

(2) Designate an individual who will be responsible for radiation protection for the machine. Such individuals shall:

(i) Be qualified by training and experience concerning all hazards and precautions involved in operating the machine for which he is responsible;

(ii) Upon request by the Department provide a detailed program of radiation safety for effective compliance with the applicable requirements of these regulations;

(iii) Give instructions concerning hazards and safety practices to individuals who may be occupationally exposed to radiation from the machine; and,

(iv) Make surveys and carry out other procedures as required by these regulations.

When in the opinion of the Department, the individual designated to be responsible for radiation safety does not have qualifications sufficient to insure such safety, the Department may order the registrant to designate another individual who meets the requirements of this subparagraph.

(b) A Notice of Registration will be provided by the Department and shall be retained by the registrant for the registration period indicated thereon.

(c) The registrant shall notify the Department within ten (10) days after any change which renders the information on the registration no longer accurate.

(d) The owner or person having possession of any registered radiation machine shall re-register such machine with the Department every two years as long as the activity requiring such registration continues.

(e) No person, in any advertisement, shall refer to the fact that a radiation machine is registered with the Department and no person shall state or imply that any activity under such registration has been approved by the Department.

(f) The registrant shall be subject to all applicable requirements of these regulations.

(g) Whenever a manufacturer, his agent or a dealer sells or transfers title to a radiation machine, said manufacturer, his agent or the dealer shall give written notification thereof to the Department. Written notification shall be given within 15 days of such sale or transfer of title and shall include the name and address of the new owner or owners.

(h) Whenever an owner sells, transfers title, or disposes of a radiation machine, said owner shall give written notification thereof to the Department. This written notification shall be given within 15 days of such sale, transfer of title, or disposal, and shall include the name and address of the owner(s) and details of the final disposal of the machine.

RECORDS, INSPECTIONS, AND TESTS

Sec. B.70 Records. Each licensee and registrant shall keep records showing the receipt, transfer, and disposal of all sources of radiation.

Sec. B.71 Inspections.

(a) The Department has the right to conduct prelicensing inspections to verify information contained in applications and secure additional information deemed necessary to make a reasonable determination as to whether to issue a license and whether any special conditions should be attached thereto by visiting the facility or location where sources of radiation would be possessed or used.

(b) Each licensee and registrant shall afford the Department, at all reasonable times, opportunity to inspect sources of radiation and the premises and facilities wherein such sources of radiation are used or stored.

(c) Each licensee and registrant shall make available to the Department for inspection, upon reasonable notice, records maintained pursuant to these regulations.

Sec. B.72 Tests. Each licensee and registrant shall perform, upon instructions from the Department, or shall permit the Department to perform such reasonable tests as the Department deems appropriate or necessary including, but not limited to, tests of:

(a) Sources of radiation;

(b) Facilities wherein sources of radiation are used or stored;

(c) Radiation detection and monitoring instruments; and,

(d) Other equipment and devices used in connection with utilization or storage of licensed or registered sources of radiation.

Sec. B.73 Film Badge Services. Licensees or registrants who use film badges to satisfy a requirement of these regulations, shall utilize film badge services approved by the Montana State Department of Health.

RECIPROCITY

Sec. B.90 Reciprocal Recognition of Licenses.

(a) Subject to these regulations, any person who possesses a specific license or equivalent licensing document issued by the U. S. Atomic Energy Commission or any agreement state, other than this state, may conduct the activities authorized in such licensing document within this state for a period not in excess of twenty (20) days in any period of twelve (12) consecutive months without obtaining a specific license from the Department, provided that:

(1) The licensing document does not limit the activity authorized by such document to specified installations or locations; and,

(2) The out-of-state licensee notifies the Department in writing at least five (5) days prior to engaging in such activity. Such notification shall indicate the location, period, and type of proposed possession and use within this state, and shall be accompanied by a copy of the pertinent licensing document. If, for a specific case, the five (5) day period would impose an undue hardship on the out-of-state licensee, he may, upon application to the Department, obtain permission to proceed sooner; and,

(3) The out-of-state licensee complies with all applicable regulations of the Department and with all the terms and conditions of his licensing document, except any such terms and

conditions which may be inconsistent with applicable regulations of the Department; and,

(4) The out-of-state licensee supplies such other information as the Department may request.

(b) To the extent provided in Sections B.3, B.4, and B.22, any person may transfer, receive, acquire, own, possess, and use any equipment, device, commodity, or other product containing radioactive material which has been manufactured, processed, or produced in accordance with a specific license or equivalent licensing document issued by the U. S. Atomic Energy Commission or any agreement state.

(c) Notwithstanding the provisions of paragraph (a) of this Section B.90, any person who holds a specific license or equivalent licensing document issued by the U. S. Atomic Energy Commission or an agreement state authorizing the holder to manufacture, install, or service a device described in Section B.22(c)(1) within areas subject to the jurisdiction of the licensing body is hereby granted a general license to install and service such device in this state provided that:

(1) Such person shall file a report with the Department within thirty (30) days after the end of each calendar quarter in which any device is transferred to or installed in this state. Each such report shall identify each general licensee by name and address, the type of device transferred, and the quantity and type of radioactive material contained in the device;

(2) The device has been manufactured, labeled, installed, and serviced in accordance with applicable provisions of the specific license or equivalent licensing document issued to such person by the U. S .Atomic Energy Commission or an agreement state;

(3) Such person shall assure that any labels required to be affixed to the device under regulations of the authority which licensed manufacture of the device bear a statement that "Removal of this label is prohibited"; and,

(4) The holder of the specific license or equivalent licensing document shall furnish to each general licensee to whom he transfers such device, or on whose premises he installs such device, a copy of the general license contained in Section B.22(c).

(d) The Department may withdraw, limit, or qualify its acceptance of any specific license or equivalent licensing document issued by another agency, or any product distributed pursuant to such licensing document, upon determining that such action is necessary in order to prevent undue hazard to public health and safety or property.

TRANSPORTATION

Sec. B.100 Interstate Transportation of Radioactive Materials.

(a) The provisions of this section apply to transportation of radioactive material, or the delivery of radioactive material to a carrier for transportation, which is not subject to the rules and regulations of the U. S. Department of Transportation and other agencies of the United States having jurisdiction.

(b) No licensee shall transport any radioactive material outside of the confines of his plant or other authorized location of use, or deliver any radioactive material to a carrier for transportation, unless the licensee complies with all requirements, appropriate to the mode of transportation, relating to the packaging of the radioactive material and to the marking and labeling of the package and transporting vehicle, of the rules and regulations published by the U. S. Department of Transportation (46 C.F.R. Part 146, 49 C.F.R. Parts 173-179 and 14 C.F.R. Part 103) to the same extent as if the transportation were subject to the rules and regulations of that agency.

SCHEDULE A

The following devices and equipment incorporating radioactive material, when manufactured, tested, and labeled by the manufacturer in accordance with the specifications contained in a specific license or equivalent licensing document issued by the Department, the U. S. Atomic Energy Commission, or any agreement state are placed under a general license pursuant to Section B.22 (a) (1).

(a) **Static Elimination Device.** Devices designed for use as static eliminators which contain, as a sealed source or sources, radioactive material consisting of a total of not more than five hundred (500) microcuries of polonium-210 per device.

(b) **Spark-Gap and Electronic Tubes.** Spark-gap tubes and electronic tubes which contain radioactive material consisting of not more than five (5) microcuries per tube of cesium-137, or nickel-63, or krypton-85 gas, or not more than one (1) microcurie per tube of cobalt-60 or not more than five (5) micrograms of radium-226 per tube.

(c) **Light Meter.** Devices designed for use in measuring or determining light intensity which contain, as a sealed source or sources, radioactive material consisting of a total of not more than two hundred (200) microcuries of strontium-90 per device.

(d) **Ion Generating Tube.** Devices designed for ionization of air which contain, as a sealed source or sources, radioactive material consisting of a total of not more than five hundred (500) microcuries of polonium-210 per device or a total of not more than fifty (50) millicuries of hydrogen-3 (tritium) per device.

Part B

SCHEDULE B

GENERALLY LICENSED QUANTITIES

Radioactive material	Column No. I Not as a sealed source (microcuries)	Column No. II As a sealed source (microcuries)
Antimony (Sb^{124})	1	10
Arsenic 76 (As^{76})	10	10
Arsenic 77 (As^{77})	10	10
Barrium-lanthanum 140 (BaLa^{140})	1	10
Beryllium (Be^{7})	50	50
Cadmium-silver 109 (CdAg^{109})	10	10
Calcium 45 (Ca^{45})	10	10
Carbon 14 (C^{14})	50	50
Cerium-praseodymium 144 (CePr^{144})	1	10
Cesium-barium 137 (CsBa^{137})	1	10
Chlorine 36 (Cl^{36})	1	10
Chromium 51 (Cr^{51})	50	50
Cobalt 60 (Co^{60})	1	10
Copper 64 (Cu^{64})	50	50
Europium 154 (Eu^{154})	1	10
Fluorine 18 (F^{18})	50	50
Gallium 72 (Ga^{72})	10	10
Germanium 71 (Ge^{71})	50	50
Gold 198 (Au^{198})	10	10
Gold 199 (Au^{199})	10	10
Hydrogen 3 (tritium) (H^{3})	250	250
Indium 114 (In^{114})	1	10
Iodine 131 (I^{131})	10	10
Iridium 192 (Ir^{192})	10	10
Iron 55 (Fe^{55})	50	50
Iron 59 (Fe^{59})	1	10
Lanthanum 140 (La^{140})	10	10
Manganese 52 (Mn^{52})	1	10
Manganese 56 (Mn^{56})	50	50
Molybdenum 99 (Mo^{99})	10	10
Nickel 59 (Ni^{59})	1	10
Nickel 63 (Ni^{63})	1	10
Niobium 95 (Nb^{95})	10	10
Palladium 109 (Pd^{109})	10	10
Palladium-rhodium 103 (PdRh^{103})	50	50
Phosphorus 32 (P^{32})	10	10
Polonium 210 (Po^{210})	0.1	1
Potassium 42 (K^{42})	10	10
Praseodymium 143 (Pr^{143})	10	10
Promethium 147 (Pm^{147})	10	10
Radium 226 (Ra^{226})	0.1	1
Rhenium 186 (Re^{186})	10	10
Rhodium 105 (Rh^{105})	10	10
Rubidium 86 (Rb^{86})	10	10

Part B

SCHEDULE B

GENERALLY LICENSED QUANTITIES—Continued

Radioactive material	Column No. I Not as a sealed source (microcuries)	Column No. II As a sealed source (microcuries)
Ruthenium-rhodium 106 ($RuRh^{106}$)	1	10
Samarium 153 (Sm^{153})	10	10
Scandium 46 (Sc^{46})	1	10
Silver 105 (Ag^{105})	1	10
Silver 111 (Ag^{111})	10	10
Sodium 22 (Na^{22})	10	10
Sodium 24 (Na^{24})	10	10
Strontium 89 (Sr^{89})	1	10
Strontium-yttrium 90 (SrY^{90})	0.1	1
Sulfur 35 (S^{35})	50	50
Tantalum 182 (Ta^{182})	10	10
Technetium 96 (Tc^{96})	1	10
Technetium 99 (Tc^{99})	1	10
Tellurium 127 (Te^{127})	10	10
Tellurium 129 (Te^{129})	1	10
Thallium 204 (Tl^{204})	50	50
Tin 113 (Sn^{113})	10	10
Tungsten 185 (W^{185})	10	10
Vanadium 48 (V^{48})	1	10
Yttrium 90 (Y^{90})	1	10
Yttrium 91 (Y^{91})	1	10
Zinc 65 (Zn^{65})	10	10
Beta and/or gamma emitting radioactive material not listed above	1	10

Part B

SCHEDULE C

EXEMPT CONCENTRATIONS

Element (atomic number)	Isotope	Column I Gas concentration uc/ml[1]	Column II Liquid and solid concentration uc/ml[2]
Antimony (51)	Sb^{122}	....	$3x10^{-4}$
	Sb^{124}	....	$2x10^{-4}$
	Sb^{125}	....	$1x10^{-3}$
Argon (18)	A^{37}	$1x10^{-3}$	....
	A^{41}	$4x10^{-7}$	....
Arsenic (33)	As^{73}	....	$5x10^{-3}$
	As^{74}	....	$5x10^{-4}$
	As^{76}	....	$2x10^{-4}$
	As^{77}	....	$8x10^{-4}$
Barium (56)	Ba^{131}	....	$2x10^{-3}$
	Ba^{140}	....	$3x10^{-4}$
Beryllium (4)	Be^{7}	....	$2x10^{-2}$
Bismuth (83)	Bi^{206}	....	$4x10^{-4}$
Bromine (35)	Br^{82}	$4x10^{-7}$	$3x10^{-3}$
Cadmium (48)	Cd^{109}	....	$2x10^{-3}$
	Cd^{115m}	....	$3x10^{-4}$
	Cd^{115}	....	$3x10^{-4}$
Calcium (20)	Ca^{45}	....	$9x10^{-5}$
	Ca^{47}	....	$5x10^{-4}$
Carbon (6)	C^{14}	$1x10^{-6}$	$8x10^{-3}$
Cerium (58)	Ce^{141}	....	$9x10^{-4}$
	Ce^{143}	....	$4x10^{-4}$
	Ce^{144}	....	$1x10^{-4}$
Cesium (55)	Cs^{131}	....	$2x10^{-2}$
	Cs^{134m}	....	$6x10^{-2}$
	Cs^{134}	....	$9x10^{-5}$
Chlorine (17)	Cl^{38}	$9x10^{-7}$	$4x10^{-2}$
Chromium(24)	Cr^{51}	....	$2x10^{-2}$
Cobalt (27)	Co^{57}	....	$5x10^{-3}$
	Co^{58}	....	$1x10^{-3}$
	Co^{60}	....	$5x10^{-4}$
Copper (29)	Cu^{64}	....	$3x10^{-3}$
Dysprosium (66)	Dy^{165}	....	$4x10^{-3}$
	Dy^{166}	....	$4x10^{-4}$
Erbium (68)	Er^{169}	....	$9x10^{-4}$
	Er^{171}	....	$1x10^{-3}$
Europium (63)	Eu^{152}	....	$6x10^{-4}$
	(T/2=9.2 Hrs.)	....	....
	Eu^{155}	....	$2x10^{-3}$
Fluorine (9)	F^{18}	$2x10^{-6}$	$8x10^{-3}$
Gadolinium (64)	Gd^{153}	....	$2x10^{-3}$
	Gd^{159}	....	$8x10^{-4}$
Gallium (31)	Ga^{72}	....	$4x10^{-4}$
Germanium (32)	Ge^{71}	....	$2x10^{-2}$
Gold (79)	Au^{196}	....	$2x10^{-3}$
	Au^{198}	....	$5x10^{-4}$
	Au^{199}	....	$2x10^{-3}$
Hafnium (72)	Hf^{181}	....	$7x10^{-4}$
Hydrogen (1)	H^{3}	$5x10^{-6}$	$3x10^{-2}$
Indium (49)	In^{113m}	....	$1x10^{-2}$
	In^{114m}	....	$2x10^{-4}$
Iodine (53)	I^{126}	$3x10^{-9}$	$2x10^{-5}$
	I^{131}	$3x10^{-9}$	$2x10^{-5}$
	I^{132}	$8x10^{-8}$	$6x10^{-4}$
	I^{133}	$1x10^{-8}$	$7x10^{-5}$
	I^{134}	$2x10^{-7}$	$1x10^{-3}$

EXEMPT CONCENTRATIONS—Continued

Element (atomic number)	Isotope	Column I Gas concentration uc/ml[1]	Column II Liquid and solid concentration uc/ml[2]
Iridium (77)	Ir^{190}	....	2x10^{-3}
	Ir^{192}	....	4x10^{-4}
	Ir^{194}	....	3x10^{-4}
Iron (26)	Fe^{55}	....	8x10^{-3}
	Fe^{59}	....	6x10^{-4}
Krypton (36)	Kr^{85m}	1x10^{-6}	....
	Kr^{85}	3x10^{-6}	....
Lanthanum (57)	La^{140}	....	2x10^{-4}
Lead (82)	Pb^{202}	....	4x10^{-3}
Lutetium (71)	Lu^{177}	....	1x10^{-3}
Manganese (25)	Mn^{52}	....	3x10^{-4}
	Mn^{54}	....	1x10^{-3}
	Mn^{56}	....	1x10^{-3}
Mercury (80)	Hg^{197m}	....	2x10^{-3}
	Hg^{197}	....	3x10^{-3}
	Hg^{203}	....	2x10^{-4}
Molybdenum (42)	Mo^{99}	....	2x10^{-3}
Neodymium (60)	Nd^{147}	....	6x10^{-4}
	Nd^{149}	....	3x10^{-3}
Nickel (28)	Ni^{65}	....	1x10^{-3}
Niobium (columbium) (41)	Nb^{95}	....	1x10^{-3}
	Nb^{97}	....	9x10^{-3}
Osmium (76)	Os^{185}	....	7x10^{-4}
	Os^{191m}	....	3x10^{-2}
	Os^{191}	....	2x10^{-3}
	Os^{193}	....	6x10^{-4}
Palladium (46)	Pd^{103}	....	3x10^{-3}
	Pd^{109}	....	9x10^{-4}
Phosphorus (15)	P^{32}	....	2x10^{-4}
Platinum (78)	Pt^{191}	....	1x10^{-3}
	Pt^{193m}	....	1x10^{-2}
	Pt^{197m}	....	1x10^{-2}
	Pt^{197}	....	1x10^{-3}
Polonium (84)	Po^{210}	....	7x10^{-6}
Potassium (19)	K^{42}	....	3x10^{-3}
Praseodymium (59)	Pr^{142}	....	3x10^{-4}
	Pr^{143}	....	5x10^{-4}
Promethium (61)	Pm^{147}	....	2x10^{-3}
	Pm^{149}	....	4x10^{-4}
Radium (88)	Ra^{226}	....	1x10^{-7}
Radon (86)	Rn^{220}	1x10^{-7}	....
	Rn^{222}	1x10^{-8}	....
Rhenium (75)	Re^{183}	....	6x10^{-3}
	Re^{186}	....	9x10^{-4}
	Re^{188}	....	6x10^{-4}
Rhodium (45)	Rh^{103m}	....	1x10^{-1}
	Rh^{105}	....	1x10^{-3}
Rubidium (37)	Rb^{86}	....	7x10^{-4}
Ruthenium (44)	Ru^{97}	....	4x10^{-3}
	Ru^{103}	....	8x10^{-4}
	Ru^{105}	....	1x10^{-3}
	Ru^{106}	....	1x10^{-4}
Samarium (62)	Sm^{153}	....	8x10^{-4}
Scandium (21)	Sc^{46}	....	4x10^{-4}
	Sc^{47}	....	9x10^{-4}
	Sc^{48}	....	3x10^{-4}
Selenium (34)	Se^{75}	....	3x10^{-3}
Silicon (14)	Si^{31}	....	9x10^{-3}
Silver (47)	Ag^{105}	....	1x10^{-3}
	Ag^{110m}	....	3x10^{-4}
	Ag^{111}	....	4x10^{-4}

EXEMPT CONCENTRATIONS—Continued

Element (atomic number)	Isotope	Column I Gas concentration uc/ml[1]	Column II Liquid and solid concentration uc/ml[2]
Sodium (11)	Na^{24}	....	$2x10^{-3}$
Strontium (38)	Sr^{89}	....	$1x10^{-4}$
	Sr^{91}	....	$7x10^{-4}$
	Sr^{92}	....	$7x10^{-4}$
Sulfur (16)	S^{35}	$9x10^{-8}$	$6x10^{-4}$
Tantalum (73)	Ta^{182}	....	$4x10^{-4}$
Technetium (43)	Tc^{96m}	....	$1x10^{-1}$
	Tc^{96}	....	$1x10^{-3}$
Tellurium (52)	Te^{125m}	....	$2x10^{-3}$
	Te^{127m}	....	$6x10^{-4}$
	Te^{127}	....	$3x10^{-3}$
	Te^{129m}	....	$3x10^{-4}$
	Te^{131m}	....	$6x10^{-4}$
	Te^{132}	....	$3x10^{-4}$
Terbium (65)	Tb^{160}	....	$4x10^{-4}$
Thallium (81)	Tl^{200}	....	$4x10^{-3}$
	Tl^{201}	....	$5x10^{-3}$
	Tl^{202}	....	$1x10^{-3}$
	Tl^{204}	....	$1x10^{-3}$
Thulium (69)	Tm^{170}	....	$5x10^{-4}$
	Tm^{171}	....	$5x10^{-3}$
Tin (50)	Sn^{113}	....	$9x10^{-4}$
	Sn^{125}	....	$2x10^{-4}$
Tungsten (wolfram) (74)	W^{181}	....	$4x10^{-3}$
	W^{187}	....	$7x10^{-4}$
Vanadium (23)	V^{48}	....	$3x10^{-4}$
Xenon (54)	Xe^{131m}	$4x10^{-6}$	....
	Xe^{133}	$3x10^{-6}$	....
	Xe^{135}	$1x10^{-6}$	....
Ytterbium (70)	Yb^{175}	....	$1x10^{-3}$
Yttrium (39)	Y^{90}	....	$2x10^{-4}$
	Y^{91m}	....	$3x10^{-2}$
	Y^{91}	....	$3x10^{-4}$
	Y^{92}	....	$6x10^{-4}$
	Y^{93}	....	$3x10^{-4}$
Zinc (30)	Zn^{65}	....	$1x10^{-3}$
	Zn^{69m}	....	$7x10^{-4}$
	Zn^{69}	....	$2x10^{-2}$
Zirconium (40)	Zr^{95}	....	$6x10^{-4}$
	Zr^{97}	....	$2x10^{-4}$
Beta and/or gamma emitting radioactive material not listed above with half-life less than 3 years	....	$1x10^{-10}$	$1x10^{-6}$

Note 1: Many radioisotopes disintegrate into isotopes which are also radioactive. In expressing the concentrations in Schedule C, the activity stated is that of the parent isotope and takes into account the daughers.

Note 2: For purposes of Section B.4 where there is involved a combination of isotopes, the limit for the combination should be derived as follows: Determine for each isotope in the product the ratio between the concentration present in the product and the exempt concentration established in Schedule C for the specific isotope when not in combination. The sum of such ratios may not exceed "1" (i.e., unity).

EXAMPLE:

$$\frac{\text{Concentration of Isotope A in Product}}{\text{Exempt concentration of Isotope A}} + \frac{\text{Concentration of Isotope B in Product}}{\text{Exempt concentration of Isotope B}} \leqq 1$$

---

[1] Values are given only for those matelials normally used as gases.

[2] uc/gm for solids.

Part B

SCHEDULE D

GROUPS OF DIAGNOSTIC USES OF RADIOACTIVE MATERIAL IN HUMANS

Group I. Uptake, dilution, and excretion studies (does not include scans or tumor localizations).

(1) Iodine-131 or iodine-125 as sodium iodide for thyroid function studies.

(2) Iodine-131 or iodine-125 as iodinated human serum albumin (IHSA) for determination of blood and blood plasma volume.

(3) Iodine-131 or iodine-125 as labeled rose bengal for liver function studies.

(4) Iodine-131 or iodine-125 as labeled fats or fatty acids for fat absorption studies.

(5) Iodine-131 or iodine-125 as labeled iodopyracet, sodium iodohippurate, sodium diatrizoate, diatrizoate methlglucamine, sodium diprotrizoate, sodium acetrizoate, or sodium iothalamate for kidney function studies.

(6) Chromium-51 as labeled human serum albumin for gastrointestinal protein loss studies.

(7) Chromium-51 as sodium chromate for determination of red blood cell volumes and studies of red blood cell survival time.

(8) Iron-59 as chloride, citrate, or sulfate for iron turnover studies.

(9) Cobalt-57, cobalt-58, or cobalt-60 as labeled cyanocobalamin (vitamin B-12) for intestinal absorption studies.

(10) Potassium-42 as chloride for potassium space determinations.

Group II. Scans and tumor localizations.

(1) Iodine-131 as sodium iodide for thyroid scans.

(2) Iodine-131 as iodinated human serum albumin (IHSA) for brain tumor localization and cardiac scans.

(3) Iodine-131 as macroaggregated iodinated human serum albumin for lung scans.

(4) Iodine-131 as colloidal (microaggregated) iodinated human serum albumin for liver scans.

(5) Iodine-131 as labeled rose bengal for liver scans.

(6) Iodine-131 as iodopyracet, sodium iodohippurate, sodium diatrizoate, diatrizoate methylglucamine, sodium diprotrizoate, or sodium acetrizoate for kidney scans.

(7) Iodine-131 as sodium iodipamide for cardiac scans.

(8) Chromium-51 as sodium chromate for spleen scans.

(9) Gold-198 in colloidal form for liver scans.

(10) Mercury-197 as chlormerodrin for kidney and brain scans.

(11) Mercury-203 as chlormerodrin for brain scans.

(12) Strontium-85 as nitrate or chloride for bone scans in patients with diagnosed cancer.

(13) Technetium-99m as pertechnetate for brain scans.

Part B

SCHEDULE E

Radioactive Material	**Col. I* Curies**	**Col. II* Curies**	**Radioactive Material**	**Col. I* Curies**	**Col. II* Curies**
Antimony-122	1	0.01	Cesium-134	0.1	0.001
Antimony-124	1	0.01	Cesium-135	1	0.01
Antimony-125	1	0.01	Cesium-136	10	0.1
Arsenic-73	10	0.1	Cesium-137	0.1	0.001
Arsenic-74	1	0.01	Chlorine-36	1	0.01
Arsenic-76	1	0.01	Chlorine-38	100	1.
Arsenic-77	10	0.1	Chromium-51	100	1.
Barium-131	10	0.1	Cobalt-57	10	0.1
Barium-140	1	0.01	Cobalt-58m	100	1.
Beryllium-7	10	0.1	Cobalt-58	1	0.01
Bismuth-210	0.1	0.001	Cobalt-60	0.1	0.001
Bromine-82	10	0.1	Copper-64	10	0.1
Cadmium-109	1	0.01	Dysprosium-165	100	1.
Cadmium-115m	1	0.01	Dysprosium-166	10	0.1
Cadmium-115	10	0.1	Erbium-169	10	0.1
Calcium-45	1	0.01	Erbium-171	10	0.1
Calcium-47	10	0.1	Europium-152 9.2 h	10	0.1
Carbon-14	100	1.	Europium-152 13 y	0.1	0.001
Cerium-141	10	0.1	Europium-154	0.1	0.001
Cerium-143	10	0.1	Europium-155	1	0.01
Cerium-144	0.1	0.001	Fluorine-18	100	1.
Cesium-131	100	1.	Gadolinium-153	1	0.01
Cesium-134m	100	1.	Gadolinium-159	10	0.1

---

*Refer to Sec. B.27(a)(2) & (a)(3).

Radioactive Material	Col. I* Curies	Col. II* Curies
Gallium-72	10	0.1
Germanium-71	100	1.
Gold-198	10	0.1
Gold-199	10	0.1
Hafnium-181	1	0.01
Holmium-166	10	0.1
Hydrogen-3	100	1.
Indium-133m	100	1.
Indium-114m	1	0.01
Indium-115m	100	1.
Indium-115	1	0.01
Iodine-125	0.1	0.001
Iodine-126	0.1	0.001
Iodine-129	0.1	0.001
Iodine-131	0.1	0.001
Iodine-132	10	0.1
Iodine-133	1	0.01
Iodine-134	10	0.1
Iodine-135	1	0.01
Iridium-192	1	0.01
Iridium-194	10	0.1
Iron-55	10	0.1
Iron-59	1	0.01
Krypton-85	100	1.
Krypton-87	10	0.1
Lanthanum-140	1	0.01
Lutetium-177	10	0.1
Manganese-52	1	0.01
Manganese-54	1	0.01
Manganese-56	10	0.1
Mercury-197m	10	0.1
Mercury-197	10	0.1
Mermury-203	1	0.01
Molybdenum-99	10	0.1
Neodymium-147	10	0.1
Neodymium-149	10	0.1
Nickel-59	10	0.1
Nickel-63	1	0.01
Nickel-65	10	0.1
Niobium-93m	1	0.01
Niobium-95	1	0.01
Niobium-97	100	1.
Osmium-185	1	0.01

Radioactive Material	Col. I* Curies	Col. II* Curies
Osmium-191m	100	1.
Osmium-191	10	0.1
Osmium-193	10	0.1
Palladium-103	10	0.1
Palladium-109	10	0.1
Phosphorus-32	1	0.01
Platinum-191	10	0.1
Platinum-193m	100	1.
Platinum-193	10	0.1
Platinum-197m	100	1.
Platinum-197	10	0.1
Polonium-210	0.01	0.0001
Potassium-42	1	0.01
Praseodymium-142	10	0.1
Praseodymium-143	10	0.1
Promethium-147	1	0.01
Promethium-149	10	0.1
Rhenium-186	10	0.1
Rhenium-188	10	0.1
Rhodium-103m	1,000	10.
Rhodium-105	10	0.1
Rubidium-86	1	0.01
Rubidium-87	1	0.01
Ruthenium-97	100	1.
Ruthenium-103	1	0.01
Ruthenium-105	10	0.1
Ruthenium-106	0.1	0.001
Samarium-151	1	0.01
Samarium-153	10	0.1
Scandium-46	1	0.01
Scandium-47	10	0.1
Scandium-48	1	0.01
Selenium-75	1	0.01
Silicon-31	10	0.1
Silver-105	1	0.01
Silver-110m	0.1	0.001
Silver-111	10	0.1
Sodium-22	0.1	0.001
Sodium-24	1	0.01
Strontium-85m	1,000	10.
Strontium-85	1	0.01

---

*Refer to Sec. B.27(a)(2) & (a)(3).

Radioactive Material	Col. I* Curies	Col. II* Curies
Strontium-89	1	0.01
Strontium-90	0.01	0.0001
Strontium-91	10	0.1
Strontium-92	10	0.1
Sulphur-35	10	0.1
Tantalum-182	1	0.01
Technetium-96	10	0.1
Technetium-97m	10	0.1
Technetium-97	10	0.1
Technetium-99m	100	1.
Technetium-99	1	0.01
Tellurium-125m	1	0.01
Tellurium-127m	1	0.01
Tellurium-127	10	0.1
Tellurium-129m	1	0.01
Tellurium-129	100	1.
Tellurium-131m	10	0.1
Tellurium-132	1	0.01
Terbium-160	1	0.01
Thallium-200	10	0.1
Thallium-201	10	0.1
Thallium-202	10	0.1
Thallium-204	1	0.01
Thulium-170	1	0.01
Thulium-171	1	0.01
Tin-113	1	0.01
Tin-125	1	0.01
Tungsten-181	1	0.01
Tungsten-185	1	0.01
Tungsten-187	10	0.1
Vanadium-48	1	0.01
Xenon-131m	1,000	10.
Xenon-133	100	1.
Xenon-135	100	1.
Ytterbium-175	10	0.1
Yttrium-90	1	0.01
Yttrium-91	1	0.01
Yttrium-92	10	0.1
Yttrium-93	1	0.01
Zinc-65	1	0.01
Zinc-69m	10	0.1
Zinc-69	100	1.
Zirconium-93	1	0.01
Zirconium-95	1	0.01
Zirconium-97	1	0.01
Any radioactive material other than alpha emitting radioactive material not listed above	0.1	0.001

---

*Refer to Sec. B.27(a)(2) & (a)(3).

Part C

STANDARDS FOR PROTECTION AGAINST RADIATION

Sec. C.1 Purpose and Scope. This Part establishes standards for protection against radiation hazards. Except as otherwise specifically provided, this Part applies to all licensees or registrants.

PERMISSIBLE DOSES, LEVELS, AND CONCENTRATIONS

Sec. C.2 Exposure of Individuals to Radiation in Restricted Areas.

(a) Except as provided in paragraph (b) of this section, no licensee or registrant shall possess, use, receive, or transfer sources of radiation in such a manner as to cause any individual in a restricted area to receive in any period of one calendar quarter from all sources of radiation in the licensee's or registrant's possession a dose in excess of the limits specified in the following table:

RADIATION PROTECTION LIMITS

Portion of Body	Rems per Calendar Quarter
Whole body; head and trunk; active blood-forming organs; lens of eyes; or gonads.	1¼
Hands and forearms; feet and ankles.	18¾
Skin of whole body.	7½

(b) A licensee or registrant may permit an individual in a restricted area to receive a dose to the whole body greater than that permitted under paragraph (a) of this section, provided:

(1) During any calendar quarter the dose to the whole body from sources of radiation in the licensee's or registrant's possession shall not exceed 3 rems; and,

(2) The dose to the whole body, when added to the accumulated occupational dose to the whole body, shall not exceed 5 (N-18) rems where "N" equals the individual's age in years at his last birthday; and,

(3) The licensee or registrant has determined the individual's accumulated occupational dose to the whole body on the Department of Health Form "MRH-30," or on a clear and legible record containing all the information required in that form, and has otherwise complied with the requirements of Section C.3. As used in this paragraph (b), "dose to the whole body" shall be deemed to include any dose to the whole body, gonads, active blood-forming organs, head and trunk, or lens of eye.

Sec. C.3 Determination of Accumulated Dose.

(a) This section contains requirements which must be satisfied by licensees or registrants who propose, pursuant to paragraph (b) of Section C.2, to permit individuals in a restricted area to receive exposure to radiation in excess of the limits specified in paragraph (a) of Section C.2.

(b) Before permitting any individual in a restricted area to receive exposure to radiation in excess of the limits specified in paragraph (a) of Section C.2, each licensee or registrant shall:

(1) Obtain a certificate on Department of Health Form "MRH-30", or on a clear and legible record containing all the information required in that form, signed by the individual, showing each period of time after the individual attained the age of 18, in which the individual received an occupational dose of radiation; and,

(2) Calculate on Department of Health Form "MRH-30", in accordance with the instructions appearing therein, or on a clear and legible record containing all the information required in that form, the previously accumulated occupational dose received by the individual and the additional dose allowed for that individual under Section C.2 (b).

(c) (1) In the preparation of Department of Health Form "MRH-30", or a clear and legible record containing all the information required in that form, the licensee or registrant shall make a reasonable effort to obtain reports of the individual's previously accumulated occupational dose. For each period for which the licensee or registrant obtains such reports, he shall use the dose shown in the report in preparing the form. In any case where a licensee or registrant is unable to obtain reports of the individual's occupational dose for a previous complete calendar quarter, it shall be assumed that the individual has received the occupational dose specified in whichever of the following columns apply:

Part of Body	**Column 1** Assumed Dose in Rems for Calendar Quarters Prior to January 1, 1961	**Column 2** Assumed Dose in Rems for Calendar Quarters Beginning on or After January 1, 1961
Whole body, gonads, active blood-forming organs, head and trunk, lens of eye:	3¾	1¼

(2) The licensee or registrant shall retain and preserve records used in preparing Department of Health Form "MRH-30". If calculations of the individual's accumulated occupational

dose for all periods prior to January 1, 1961 ,yields a result higher than the applicable accumulated dose value for the individual as of that date, as specified in paragraph (b) of Section C.2, the excess may be disregarded.

Sec. C.4 Exposure of Individuals to Concentrations of Radioactive Material in Restricted Areas.

(a) No licensee shall possess, use, receive, or transfer radioactive material in such a manner as to cause an individual in a restricted area to be exposed to airborne radioactive material in an average concentration in excess of the limits specified in Appendix A, Table I, of this Part. "Exposure," as used in this section, means that the individual is present in an airborne concentration. No allowance shall be made for the use of protective clothing or equipment, or particle size, except as authorized by the Department pursuant to paragraph (c) of this section.

(b) The limits given in Appendix A, Table I, of this Part are based upon exposure to the concentrations specified for forty hours in any period of seven consecutive days. In any such period where the number of hours of exposure is less than forty, the limits specified in the table may be increased proportionately. In any such period where the number of hours of exposure is greater than forty, the limits specified in the table shall be decreased proportionately.

(c) (1) Except as authorized by the Department pursuant to this paragraph, no allowance shall be made for particle size or the use of protective clothing or equipment in determining whether an individual is exposed to an airborne concentration in excess of the limits specified in Appendix A, Table I.

(2) The Department may authorize a licensee to expose an individual in a controlled area to airborne concentrations in excess of the limits specified in Appendix A, Table I, upon receipt of an application demonstrating that the concentration is composed in whole or in part of particles of such size that such particles are not respirable and that the individual will not inhale the concentrations in excess of the limits established in Appendix A, Table I. Each application under this subparagraph shall include an analysis of particle sizes in the concentrations and a description of the methods used in determining the particle sizes.

(3) The Department may authorize a licensee to expose an individual in a controlled area to airborne concentrations in

excess of the limits specified in Appendix A, Table I, upon receipt of an application demonstrating that the individual will wear appropriate protective equipment and that the individual will not inhale, ingest, or absorb quantities of radioactive material in excess of those which might otherwise be permitted under this Part for individuals in restricted areas during a 40-hour week. Each application under this subparagraph shall contain the following information:

(i) A description of the protective equipment to be employed, including the efficiency of the equipment for the material involved;

(ii) Procedures for the fitting, maintenance, and cleaning of the protective equipment;

(iii) Procedures governing the use of the protective equipment, including supervisory procedures and length of time the equipment will be used by the individuals in each work week. The proposed periods for use of the equipment by any individual should not be of such duration as would discourage observance, by the individual, of the proposed procedures; and,

(iv) The average concentrations present in the areas occupied by individuals.

Sec. C.5 Exposure of Minors.

(a) No licensee or registrant shall possess, use, or transfer sources of radiation in such a manner as to cause any individual within a restricted area, who is under 18 years of age, to receive in any period of one calendar quarter from all sources of radiation in such licensee's or registrant's possession a dose in excess of 10 percent of the limits specified in the table in paragraph (a) of Section C.2.

(b) No licensee shall possess, use, or transfer radioactive material in such a manner as to cause any individual within a restricted area, who is under 18 years of age, to be exposed to airborne radioactive material in an average concentration in excess of the limits specified in Appendix A, Table II, of this Part. For purposes of this paragraph, concentrations may be averaged over periods not greater than a week.

(c) The provisions of paragraph (c), Section C.3, shall apply to exposures subject to paragraph (b) of this section.

Sec. C.6 Permissible Levels of Radiation From External Sources in Non-restricted Areas.

(a) Except as authorized by the Department pursuant to paragraph (b) of this section no licensee or registrant shall possess, use, or transfer sources of radiation in such a manner as to create in any non-restricted area from such sources of radiation in his possession:

(1) Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of two millirems in any one hour; or,

(2) Radiation levels which, if an individual were continuously present in the area, could result in his receiving a dose in excess of 100 millirems in any seven consecutive days.

(b) Any person may apply to the Department for proposed limits upon levels of radiation in unrestricted areas in excess of those specified in paragraph (a) of this section resulting from the applicant's possession or use of sources of radiation. Such applications should include information as to anticipated average radiation levels and anticipated occupancy times for each unrestricted area involved. The Department will approve the proposed limits if the applicant demonstrates to the satisfaction of the Department that the proposed limits are not likely to cause any individual to receive a dose to the whole body in any period of one calendar year in excess of 0.5 rem.

Sec. C.7 Concentration in Effluents to Unrestricted Areas.

(a) A licensee shall not possess, use, or transfer radioactive material so as to release to an unrestricted area radioactive material in concentrations which exceed the limits specified in Appendix A, Table II of this Part, except as authorized pursuant to Section C.16 or paragraph (b) of this section. For purposes of this section, concentrations may be averaged over a period not greater than one year.

(b) An application for a license or amendment may include proposed limits higher than those specified in paragraph (a) of this section. The Department will approve the proposed limits if the applicant demonstrates:

(1) That the applicant has made a reasonable effort to minimize the radioactivity contained in effluents to unrestricted areas; and,

(2) That it is not likely that radioactive material discharged in the effluent would result in the exposure of an individual

to concentrations of radioactive material in air or water exceeding the limits specified in Appendix A, Table II of this Part.

(c) An application for higher limits pursuant to paragraph (b) of this section shall include information demonstrating that the applicant has made a reasonable effort to minimize the radioactivity discharged in effluents to unrestricted areas, and shall include, as pertinent:

(1) Information as to flow rates, total volume of effluent, peak concentration of each radionuclide in the effluent, and concentration of each radionuclide in the effluent averaged over a period of one year at the point where the effluent leaves a stack, tube, pipe, or similar conduit;

(2) A description of the properties of the effluents, including:

(i) Chemical composition;

(ii) Physical characteristics, including suspended solids content in liquid effluents, and nature of gas or aerosol for air effluents;

(iii) The hydrogen ion concentration (pH) of liquid effluents; and,

(iv) The size range of particulates in effluents released into air.

(3) A description of the anticipated human occupancy in the unrestricted area where the highest concentration of radioactive material from the effluent is expected, and, in the case of a river or stream, a description of present and proposed water uses downstream from the point of release of the effluent.

(4) Information as to the highest concentration of each radionuclide in an unrestricted area, including anticipated concentrations averaged over a period of one year;

(i) In air at any point of human occupancy; or,

(ii) In water at points of use downstream from the point of release of the effluent.

(5) The background concentration of radionuclides in the receiving river or stream prior to the release of liquid effluent.

(6) A description of the environmental monitoring equipment, including sensitivity of the system, and procedures and cal-

culations to determine concentrations of radionuclides in the unrestricted area and possible reconcentrations of radionuclides.

(7) A description of the waste treatment facilities and procedures used to reduce the concentration of radionuclides in effluents prior to their release.

(d) For the purposes of this section, the concentration limits in Appendix A, Table II of this Part shall apply at the boundary of the restricted area. The concentration of radioactive material discharged through a stack, pipe, or similar conduit may be determined with respect to the point where the material leaves the conduit. If the conduit discharges within the restricted area, the concentration at the boundary may be determined by applying appropriate factors for dilution, dispersion, or decay between the point of discharge and the boundary.

(e) In addition to limiting concentrations in effluent streams, the Department may limit quantities of radioactive materials released in air or water during a specified period of time if it appears that the daily intake of radioactive material from air, water, or food by a suitable sample of an exposed population group, averaged over a period not exceeding one year, would otherwise exceed the daily intake resulting from continuous exposure to air or water containing one-third the concentration of radioactive materials specified in Appendix A, Table II of this Part.

(f) The provisions of this section do not apply to disposal of radioactive material into sanitary sewerage systems, which is governed by Section C.17.

Sec. C.8 Orders Requiring Furnishing of Bio-Assay Services. Where necessary or desirable in order to aid in determining the extent of an individual's exposure to concentrations of radioactive material, the Department may incorporate license provisions or issue an order requiring a licensee or registrant to make available to the individual appropriate bio-assay services and to furnish a copy of the reports of such services to the Department.

PRECAUTIONARY PROCEDURES

Sec. C.9 Surveys.

(a) As used in this Part, "survey" means an evaluation of the radiation hazards incident to the production, use, release, disposal, or presence of sources of radiation under a specific set of conditions. When appropriate, such evaluation includes a physical survey of the location of materials and equipment, and measurements of levels of radiation or concentrations of radioactive material present.

(b) Each licensee or registrant shall make, or cause to be made, such surveys as may be necessary for him to comply with this Part.*

Sec. C.10 Personal Monitoring.

(a) Each licensee or registrant shall supply appropriate personnel monitoring equipment to, and shall require the use of such equipment by:

(1) Each individual who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar quarter in excess of 25 percent of the applicable value specified in paragraph (a) of Section C.2.

(2) Each individual under 18 years of age who enters a restricted area under such circumstances that he receives, or is likely to receive, a dose in any calendar quarter in excess of 5 percent of the applicable value specified in paragraph (a) of Section C.2.

(3) Each individual who enters a high radiation area.

(b) (1) "Personnel monitoring equipment" means devices designed to be worn or carried by an individual for the purpose of measuring the dose received (e.g., film badges, pocket chambers, pocket dosimeters, film rings, etc.).

(2) "Radiation area" means any area, accessible to individuals, in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 5 millirems, or in any 5 consecutive days a dose in excess of 100 millirems.

(3) "High radiation area" means any area, accessible to individuals in which there exists radiation at such levels that a major portion of the body could receive in any one hour a dose in excess of 100 millirems.

Sec. C.11 Caution Signs, Labels, and Signals.

(a) **General.**

(1) Except as otherwise authorized by the Department, symbols prescribed by this section shall use the conventional radi-

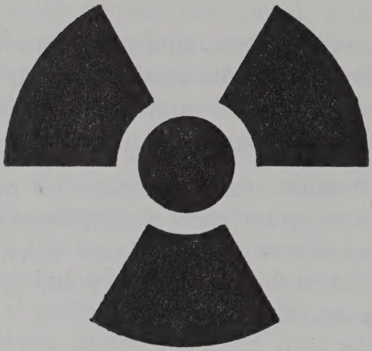
---

*The Department may require licensees or registrants to perform or permit the Department to perform such reasonable tests as the Department deems appropriate or necessary in the administration of these regulations (see Section B.72).

ation caution colors (magenta or purple on yellow background). The symbol prescribed by this section is the conventional three-bladed design:

RADIATION SYMBOL

1. Solid area is to be magenta or purple.
2. Background is to be yellow.



(2) In addition to the contents of signs and labels prescribed in this section, a licensee or registrant may provide on or near such signs and labels any additional information which may be appropriate in aiding individuals to minimize exposure to radiation.

(b) **Radiation Areas.** Each radiation area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION*
RADIATION AREA

(c) **High Radiation Areas.**

(1) Each high radiation area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

---

*or "DANGER"

CAUTION*
HIGH RADIATION AREA

(2) Each high radiation area shall be equipped with a control device which shall either cause the level of radiation to be reduced below that at which an individual might receive a dose of 100 millirems in one hour upon entry into the area or shall energize a conspicuous visible or audible alarm signal in such a manner that the individual entering and the licensee, registrant, or supervisor of the activity are made aware of the entry. In the case of a high radiation area established for a period of 30 days or less, such control device is not required.

(d) **Airborne Radioactivity Areas.**

(1) As used in this Part, "airborne radioactivity area" means (i) any room, enclosure, or operating area in which airborne radioactive material exists in concentrations in excess of the amounts specified in Appendix A, Table I, Column 1, of this Part; or (ii) any room enclosure, or operating area in which airborne radioactive material exists in concentrations which, averaged over the number of hours in any week during which individuals are in the area, exceed 25 percent of the amounts specified in Appendix A, Table I, Column 1, of this Part.

(2) Each airborne radioactivity area shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION*
AIRBORNE RADIOACTIVITY AREA

(e) **Additional Requirements.**

(1) Each area or room in which any radioactive material, other than natural uranium or thorium, is used or stored in an amount exceeding 10 times the quantity of radioactive material specified in Appendix B of this Part shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION*
RADIOACTIVE MATERIAL

(2) Each area or room in which natural uranium or thorium is used or stored in an amount exceeding one hundred times

---

*or "DANGER"

the quantity specified in Appendix B of this Part shall be conspicuously posted with a sign or signs bearing the radiation caution symbol and the words:

CAUTION*
RADIOACTIVE MATERIAL

(f) **Containers:**

(1) Except as provided in subparagraph (3) of this paragraph, each container of radioactive material shall bear a durable, clearly visible label identifying the radioactive contents.

(2) A label required pursuant to subparagraph (1) of this paragraph shall bear the radiation caution symbol and the words:

CAUTION*
RADIOACTIVE MATERIAL

It shall also provide sufficient information** to permit individuals handling or using the containers, or working in the vicinity thereof, to take precautions to avoid or minimize exposures.

(3) Notwithstanding the provisions of subparagraph (1) of this paragraph, labeling is not required:

(i) For containers that do not contain radioactive materials in quantities greater than the applicable quantities listed in Appendix B of this Part;

(ii) For containers containing only natural uranium or thorium in quantities no greater than ten times the applicable quantities listed in Appendix B of this Part;

(iii) For containers that do not contain radioactive materials in concentrations greater than the applicable concentrations listed in Column 2, Table I, Appendix A of this Part;

(iv) For containers when they are attended by an individual who takes the precautions necessary to prevent the exposure of any individual to radiation or radioactive materials in excess of the limits established by the regulations in this Part;

---

* or "DANGER."

**As appropriate, the information will include radiation levels, kinds of material, estimate of activity, date for which activity is estimated, etc.

(v) For containers when they are in transport and packaged and labeled in accordance with regulations published by the Department of Transportation.

(vi) For containers which are accessible* only to individuals authorized to handle or use them, or to work in the vicinity thereof, provided that the contents are identified to such individuals by a readily available written record; and,

(vii) For manufacturing and process equipment such as piping and tanks.

(g) All radiation machines shall be labeled in a manner which cautions individuals that radiation is produced when the machine is being operated.

Sec. C.12 Exceptions From Posting Requirements. Notwithstanding the provisions of Section C.11.

(a) A room or area is not required to be posted with a caution sign because of the presence of a sealed source, provided the radiation level twelve inches from the surface of the source container or housing does not exceed five millirems per hour.

(b) Rooms or other areas in hospitals are not required to be posted with caution signs because of the presence of patients containing radioactive material, provided that there are personnel in attendance who shall take the precautions necessary to prevent the exposure of any individual to radiation or radioactive material in excess of the limits established in this Part.

(c) Caution signs are not required to be posted in areas or rooms containing radioactive materials for periods of less than eight hours provided that

(1) the materials are constantly attended during such periods by an individual who shall take the precautions necessary to prevent the exposure of any individual to radiation or radioactive materials in excess of the limits established in this Part, and

(2) such area or room is subject to the licensee's or registrant's control.

(d) A room or other area is not required to be posted with a caution sign because of the presence of radioactive materials packaged and labeled in accordance with regulations published by the Department of Transportation.

---

*For example, containers in locations such as water filled canals, storage vaults, or hot cells.

Sec. C.13 Instruction of Personnel.

(a) Each licensee or registrant shall inform individuals working in or frequenting any portion of a restricted area of the occurrence of radiation or sources of radiation in such portions of the restricted area; shall instruct such individuals in the safety problems associated with exposure to such sources of radiation and in precautions or procedures to minimize exposure; shall instruct such individuals in the applicable provisions of Department regulations and licenses for the protection of personnel from exposures to radiation or radioactive materials; and shall advise such individuals of reports of radiation exposure which those individuals may request pursuant to this Part.

Sec. C.14 Storage of Sources of Radiation. Sources of radiation shall be secured against unauthorized removal from the place of storage.

WASTE DISPOSAL

Sec. C.15 General Requirement. No licensee shall dispose of any radioactive material except:

(a) By transfer to an authorized recipient as provided in Part B; or,

(b) As authorized pursuant to Sections C.16, C.17, C.18, or C.7.

Sec. C.16 Method of Obtaining Approval of Proposed Disposal Procedures. Any person may apply to the Department for approval of proposed procedures to dispose of radioactive material in a manner not otherwise authorized in this Part. Each application shall include a description of the radioactive material, including the quantities and kinds of radioactive material and the levels of radioactivity involved, and the proposed manner and conditions of disposal. The application, where appropriate, should also include an analysis and evaluation of pertinent information as to the nature of the environment, including topographical, geological, meterological, and hydrological characteristics; use of ground and surface waters in the general area; the nature and location of other potentially affected facilities; and procedures to be observed to minimize the risk of unexpected or hazardous exposures. The Department will not approve any application for a license to receive radioactive material from other persons for disposal on land not owned by a state or the Federal Government.

Sec. C.17 Disposal by Release into Sanitary Sewerage Systems. No licensee shall discharge radioactive material into a sanitary sewerage system unless:

(a) It is readily soluble or dispersable in water; and,

(b) The quantity of any radioactive material released into the system by the licensee in any one day does not exceed the larger of subparagraphs (1) or (2) of this paragraph:

(1) The quantity which, if diluted by the average daily quantity of sewage released into the sewer by the licensee, will result in an average concentration not greater than the limits specified in Appendix A, Table I, Column 2, of this Part; or,

(2) Ten times the quantity of such material specified in Appendix B of this Part; and,

(c) The quantity of any radioactive material released in any one month, if diluted by the average monthly quantity of water released by the licensee, will not result in an average concentration exceeding the limits specified in Appendix A, Table I, Column 2, of this Part; and,

(d) The gross quantity of radioactive material released into the sewage system by the licensee does not exceed one curie per year.

Excreta from individuals undergoing medical diagnosis or therapy with radiactive material shall be exempt from any limitations contained in this section.

Sec. C.18 Disposal by Burial in Soil. No licensee shall dispose of radioactive material by burial in soil unless:

(a) The total quantity of radioactive materials buried at any one location and time does not exceed, at the time of burial, 1,000 times the amount specified in Appendix B of this Part; and,

(b) Burial is at a minimum depth of four feet; and,

(c) Successive burials are separated by distances of at least six feet and not more than 12 burials are made in any year.

Sec. C.19 Disposal by Incineration. No licensee shall incinerate radioactive material for the purpose of disposal or preparation for disposal except as specifically approved by the Department pursuant to Sections C.7 and C.16.

RECORDS, REPORTS, AND NOTIFICATION

Sec. C.20 Records of Surveys, Radiation Monitoring, and Disposal.

(a) Each licensee or registrant shall maintain records showing the radiation exposure of all individuals for whom personnel monitoring is required under Section C.10 of this Part. Such records shall be kept on Department of Health Form "MRH-31", in accordance with the instructions contained in that form or on clear legible records containing all the information required by Department of Health Form "MRH-31". The doses entered on the forms or records shall be for periods of time not exceeding one quarter.

(b) Each licensee or registrant shall maintain records in the same units used in this Part, showing the results of surveys required by C.9(b), and disposals made under Sections C.16, C.17, and C.18.

(c) Records of individual radiation exposure which must be maintained pursuant to the provisions of paragraph (a) of this section shall be preserved until December 31, 1974, or until a date five (5) years after termination of the individual's employment or association with the licensee or registrant, whichever is later, or such other time as the Department may determine. (Records which must be maintained pursuant to this Part may be maintained in the form of microfilm.)

(d) The discontinuance of or curtailment of activities, does not relieve the licensee or registrant of responsibility for retaining all records required by this section. A licensee or registrant may, however, request the Department to accept such records. The acceptance of the records by the Department relieves the licensee or registrant of subsequent responsibility only in respect to their preservation as required by this section.

Sec. C.21 Reports of Theft or Loss of Source of Radiation. Each licensee or registrant shall report by telephone and telegraph to the Department the theft or loss of any source of radiation immediately after such occurrence becomes known.

Sec. C.22 Notification of Incidents.

(a) **Immediate Notification.** Each licensee or registrant shall immediately notify the Department by telephone and telegraph of any incident involving any source of radiation possessed by him and which may have caused or threatens to cause:

(1) Exposure to the whole body of any individual to 25 rems or more of radiation; exposure of the skin of the whole body of any individual to 150 rems or more of radiation; or exposure of the feet, ankles, hands, or forearms of any individual to 375 rems or more of radiation; or,

(2) The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 5,000 times the limits specified for such materials in Appendix A, Table II; or,

(3) A loss of one working week or more of the operation of any facilities affected; or,

(4) Damage to property in excess of $100,000.

(b) **Twenty-four Hour Notification.** Each licensee or registrant shall within 24 hours notify the Department by telephone and telegraph of any incident involving any source of radiation possessed by him and which may have caused or threatens to cause:

(1) Exposure of the whole body of any individual to 5 rems or more of radiation; exposure of the skin of the whole body of any individual to 30 rems or more of radiation; or exposure of the feet, ankles, hands, or forearms to 75 rems or more of radiation; or,

(2) The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 500 times the limits specified for such materials in Appendix A, Table II; or,

(3) A loss of one day or more of the operation of any facilities affected; or,

(4) Damage to property in excess of $1,000 but less than $100,000.

(c) Any report filed with the Department pursuant to this section shall be prepared in such a manner that names of individuals who have received exposure to radiation will be stated in a separate part of the report.

Sec. C.23 Report to Former Employees and Others of Exposure to Radiation.

(a) A licensee or registrant, at the request of any individual formerly employed or associated with him (i.e., student, craftsman, etc.), shall furnish to such individual a report of his exposure to radiation as shown in records maintained pursuant to Section C.20(a). Such report shall be furnished within 30 days from the time the request is made; shall cover each calendar quarter of the individual's employment or association involving exposure to radiation, or such lesser period as may be requested by the individual. The report shall also include the results of any calculations and analyses of radioactive material deposited in the body of the individual and made pursuant to the provisions of Section C.8. The report shall be in writing and contain the following statement:

> "This report is furnished to you under the provisions of the Montana State Department of Health regulations entitled Rules and Regulations for the Control of Radiation in the State of Montana. You should preserve this report for future reference."

(b) The individual's request should include appropriate identifying data, such as social security number and dates and locations of employment or association.

Sec. C.24 Reports of Overexposures and Excessive Levels and Concentrations.

(a) In addition to any notification required by Section C.22, each licensee or registrant shall make a report, in writing, within 30 days to the Department of (1) each exposure of an individual to radiation or concentrations of radioactive material in excess of any applicable limit as set forth in this Part or as otherwise approved by the Department; (2) any incident for which notification is required by Section C.22; and (3) levels of radiation or concentrations of radioactive material (not involving excessive exposure of any individual) in an unrestricted area in excess of ten times any applicable limit as set forth in this part or as otherwise approved by the Department. Each report required under this paragraph shall describe the extent of exposure of individuals to radiation or to radioactive material; levels of radiation and concentrations of radioactive material involved; the cause of the exposure, levels, or concentrations; and corrective steps taken or planned to assure against a recurrence.

(b) In any case where a licensee or registrant is required, pursuant to the provisions of this section, to report to the Department any exposure of an individual to radiation or to concentrations of radioactive material, the licensee or registrant shall not later than the making of such report to the Department also notify such individual of the nature and extent of exposure. Such notice shall be in writing and shall contain the following statement:

> "This report is furnished to you under the provisions of the Montana State Department of Health regulations entitled

Rules and Regulations for the Control of Radiation in the State of Montana. You should preserve this report for future reference."

(c) Any report filed with the Department pursuant to this section shall be prepared in such a manner that names of individuals who have received exposure to radiation will be stated in a separate part of the report.

Sec. C.25 Notice to Employees and Others of Exposure to Radiation. Each licensee or registrant, at the request of any individual employed or associated with him, shall advise such individual annually of the individual's exposure to radiation as shown in records maintained by the licensee or registrant pursuant to Section C.20(a).

Sec. C.26 Vacating Premises. Each specific licensee shall, no less than 30 days before vacating or relinquishing possession or control of premises which may have been contaminated with radioactive material as a result of his activities, notify the Department in writing of intent to vacate. The Department may require that the licensee decontaminate, or have decontaminated, the location to a degree consistent with subsequent use as an unrestricted area, the details to be specified in each case by the Department.

Part C

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See Sec. C.4, C.17 and notes at end of appendix)

Element (atomic number)	Isotope[1]		TABLE I		TABLE II	
			Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
Actinium (89)	Ac 227	S	2×10^{-12}	6×10^{-5}	8×10^{-14}	2×10^{-6}
		I	3×10^{-11}	9×10^{-3}	9×10^{-13}	3×10^{-4}
	Ac 228	S	8×10^{-8}	3×10^{-3}	3×10^{-9}	9×10^{-5}
		I	2×10^{-8}	3×10^{-3}	6×10^{-10}	9×10^{-5}
Americium (95)	Am 241	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	2×10^{-5}
	Am 242 m	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	3×10^{-10}	3×10^{-3}	9×10^{-12}	9×10^{-5}
	Am 242	S	4×10^{-8}	4×10^{-3}	1×10^{-9}	1×10^{-4}
		I	5×10^{-8}	4×10^{-3}	2×10^{-9}	1×10^{-4}
	Am 243	S	6×10^{-12}	1×10^{-4}	2×10^{-13}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	4×10^{-12}	3×10^{-5}
	Am 244	S	4×10^{-6}	1×10^{-1}	1×10^{-7}	5×10^{-3}
		I	2×10^{-5}	1×10^{-1}	8×10^{-7}	5×10^{-3}
Antimony (51)	Sb 122	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
	Sb 124	S	2×10^{-7}	7×10^{-4}	5×10^{-9}	2×10^{-5}
		I	2×10^{-8}	7×10^{-4}	7×10^{-10}	2×10^{-5}
	Sb 125	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	3×10^{-8}	3×10^{-3}	9×10^{-10}	1×10^{-4}
Argon (18)	A 37	Sub[2]	6×10^{-3}	....	1×10^{-4}	....
	A 41	Sub	2×10^{-6}	....	4×10^{-8}	....
Arsenic (33)	As 73	S	2×10^{-6}	1×10^{-2}	7×10^{-8}	5×10^{-4}
		I	4×10^{-7}	1×10^{-2}	1×10^{-8}	5×10^{-4}
	As 74	S	3×10^{-7}	2×10^{-3}	1×10^{-8}	5×10^{-5}
		I	1×10^{-7}	2×10^{-3}	4×10^{-9}	5×10^{-5}
	As 76	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
		I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
	As 77	S	5×10^{-7}	2×10^{-3}	2×10^{-8}	8×10^{-5}
		I	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
Astatine (85)	At 211	S	7×10^{-9}	5×10^{-5}	2×10^{-10}	2×10^{-6}
		I	3×10^{-8}	2×10^{-3}	1×10^{-9}	7×10^{-5}
Barium (56)	Ba 131	S	1×10^{-6}	5×10^{-3}	4×10^{-8}	2×10^{-4}
		I	4×10^{-7}	5×10^{-3}	1×10^{-8}	2×10^{-4}
	Ba 140	S	1×10^{-7}	8×10^{-4}	4×10^{-9}	3×10^{-5}
		I	4×10^{-8}	7×10^{-4}	1×10^{-9}	2×10^{-5}
Berkelium (97)	Bk 249	S	9×10^{-10}	2×10^{-2}	3×10^{-11}	6×10^{-4}
		I	1×10^{-7}	2×10^{-2}	4×10^{-9}	6×10^{-4}
	Bk 250	S	1×10^{-7}	6×10^{-3}	5×10^{-9}	2×10^{-4}
		I	1×10^{-6}	6×10^{-3}	4×10^{-8}	2×10^{-4}
Beryllium (4)	Be 7	S	6×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
		I	1×10^{-6}	5×10^{-2}	4×10^{-8}	2×10^{-3}
Bismuth (83)	Bi 206	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
		I	1×10^{-7}	1×10^{-3}	5×10^{-9}	4×10^{-5}
	Bi 207	S	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
		I	1×10^{-8}	2×10^{-3}	5×10^{-10}	6×10^{-5}
	Bi 210	S	6×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
		I	6×10^{-9}	1×10^{-3}	2×10^{-10}	4×10^{-5}
	Bi 212	S	1×10^{-7}	1×10^{-2}	3×10^{-9}	4×10^{-4}
		I	2×10^{-7}	1×10^{-2}	7×10^{-9}	4×10^{-4}
Bromine (35)	Br 82	S	1×10^{-6}	8×10^{-3}	4×10^{-8}	3×10^{-4}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See Sec. C.4, C.17 and notes at end of appendix)

Element (atomic number)	Isotope[1]		TABLE I		TABLE II	
			Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
Cadmium (48)	Cd 109	S	5×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
		I	7×10^{-8}	5×10^{-3}	3×10^{-9}	2×10^{-4}
	Cd 115 m	S	4×10^{-8}	7×10^{-4}	1×10^{-9}	3×10^{-5}
		I	4×10^{-8}	7×10^{-4}	1×10^{-9}	3×10^{-5}
	Cd 115	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	4×10^{-5}
Calcium (20)	Ca 45	S	3×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
		I	1×10^{-7}	5×10^{-3}	4×10^{-9}	2×10^{-4}
	Ca 47	S	2×10^{-7}	1×10^{-3}	6×10^{-9}	5×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}
Californium (98)	Cf 249	S	2×10^{-12}	1×10^{-4}	5×10^{-14}	4×10^{-6}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	2×10^{-5}
	Cf 250	S	5×10^{-12}	4×10^{-4}	2×10^{-13}	1×10^{-5}
		I	1×10^{-10}	7×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf 251	S	2×10^{-12}	1×10^{-4}	6×10^{-14}	4×10^{-6}
		I	1×10^{-10}	8×10^{-4}	3×10^{-12}	3×10^{-5}
	Cf 252	S	2×10^{-11}	7×10^{-4}	7×10^{-13}	2×10^{-5}
		I	1×10^{-10}	7×10^{-4}	4×10^{-12}	2×10^{-5}
	Cf 253	S	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
		I	8×10^{-10}	4×10^{-3}	3×10^{-11}	1×10^{-4}
	Cf 254	S	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
		I	5×10^{-12}	4×10^{-6}	2×10^{-13}	1×10^{-7}
Carbon (6)	C 14	S	4×10^{-6}	2×10^{-2}	1×10^{-7}	8×10^{-4}
	(CO_2)	Sub	5×10^{-5}	....	1×10^{-6}	....
Cerium (58)	Ce 141	S	4×10^{-7}	3×10^{-3}	2×10^{-8}	9×10^{-5}
		I	2×10^{-7}	3×10^{-3}	5×10^{-9}	9×10^{-5}
	Ce 143	S	3×10^{-7}	1×10^{-3}	9×10^{-9}	4×10^{-5}
		I	2×10^{-7}	1×10^{-3}	7×10^{-9}	4×10^{-5}
	Ce 144	S	1×10^{-8}	3×10^{-4}	3×10^{-10}	1×10^{-5}
		I	6×10^{-9}	3×10^{-4}	2×10^{-10}	1×10^{-5}
Cesium (55)	Cs 131	S	1×10^{-5}	7×10^{-2}	4×10^{-7}	2×10^{-3}
		I	3×10^{-6}	3×10^{-2}	1×10^{-7}	9×10^{-4}
	Cs 134 m	S	4×10^{-5}	2×10^{-1}	1×10^{-6}	6×10^{-3}
		I	6×10^{-6}	3×10^{-2}	2×10^{-7}	1×10^{-3}
	Cs 134	S	4×10^{-8}	3×10^{-4}	1×10^{-9}	9×10^{-6}
		I	1×10^{-8}	1×10^{-3}	4×10^{-10}	4×10^{-5}
	Cs 135	S	5×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	9×10^{-8}	7×10^{-3}	3×10^{-9}	2×10^{-4}
	Cs 136	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	9×10^{-5}
		I	2×10^{-7}	2×10^{-3}	6×10^{-9}	6×10^{-5}
	Cs 137	S	6×10^{-8}	4×10^{-4}	2×10^{-9}	2×10^{-5}
		I	1×10^{-8}	1×10^{-3}	5×10^{-10}	4×10^{-5}
Chlorine (17)	Cl 36	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	8×10^{-5}
		I	2×10^{-8}	2×10^{-3}	8×10^{-10}	6×10^{-5}
	Cl 38	S	3×10^{-6}	1×10^{-2}	9×10^{-8}	4×10^{-4}
		I	2×10^{-6}	1×10^{-2}	7×10^{-8}	4×10^{-4}
Chromium (24)	Cr 51	S	1×10^{-5}	5×10^{-2}	4×10^{-7}	2×10^{-3}
		I	2×10^{-6}	5×10^{-2}	8×10^{-8}	2×10^{-3}
Cobalt (27)	Co 57	S	3×10^{-6}	2×10^{-2}	1×10^{-7}	5×10^{-4}
		I	2×10^{-7}	1×10^{-2}	6×10^{-9}	4×10^{-4}
	Co 58 m	S	2×10^{-5}	8×10^{-2}	6×10^{-7}	3×10^{-3}
		I	9×10^{-6}	6×10^{-2}	3×10^{-7}	2×10^{-3}

See footnotes at end of table.

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See Sec. C.4, C.17 and notes at end of appendix)

Element (atomic number)	Isotope[1]		TABLE I		TABLE II	
			Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
	Co 58	S	$8x10^{-7}$	$4x10^{-3}$	$3x10^{-8}$	$1x10^{-4}$
		I	$5x10^{-8}$	$3x10^{-3}$	$2x10^{-9}$	$9x10^{-5}$
	Co 60	S	$3x10^{-7}$	$1x10^{-3}$	$1x10^{-8}$	$5x10^{-5}$
		I	$9x10^{-9}$	$1x10^{-3}$	$3x10^{-10}$	$3x10^{-5}$
Copper (29)......................	Cu 64	S	$2x10^{-6}$	$1x10^{-9}$	$7x10^{-8}$	$3x10^{-4}$
		I	$1x10^{-6}$	$6x10^{-3}$	$4x10^{-8}$	$2x10^{-4}$
Curium (96).....................	Cm 242	S	$1x10^{-10}$	$7x10^{-4}$	$4x10^{-12}$	$2x10^{-5}$
		I	$2x10^{-10}$	$7x10^{-4}$	$6x10^{-12}$	$3x10^{-5}$
	Cm 243	S	$6x10^{-12}$	$1x10^{-4}$	$2x10^{-13}$	$5x10^{-6}$
		I	$1x10^{-10}$	$7x10^{-4}$	$3x10^{-12}$	$2x10^{-5}$
	Cm 244	S	$9x10^{-12}$	$2x10^{-4}$	$3x10^{-13}$	$7x10^{-6}$
		I	$1x10^{-10}$	$8x10^{-4}$	$3x10^{-12}$	$3x10^{-5}$
	Cm 245	S	$5x10^{-12}$	$1x10^{-4}$	$2x10^{-13}$	$4x10^{-6}$
		I	$1x10^{-10}$	$8x10^{-4}$	$4x10^{-12}$	$3x10^{-5}$
	Cm 246	S	$5x10^{-12}$	$1x10^{-4}$	$2x10^{-13}$	$4x10^{-6}$
		I	$1x10^{-10}$	$8x10^{-4}$	$4x10^{-12}$	$3x10^{-5}$
	Cm 247	S	$5x10^{-12}$	$1x10^{-4}$	$2x10^{-13}$	$4x10^{-6}$
		I	$1x10^{-10}$	$6x10^{-4}$	$4x10^{-12}$	$2x10^{-5}$
	Cm 248	S	$6x10^{-13}$	$1x10^{-5}$	$2x10^{-14}$	$4x10^{-7}$
		I	$1x10^{-11}$	$4x10^{-5}$	$4x10^{-13}$	$1x10^{-6}$
	Cm 249	S	$1x10^{-5}$	$6x10^{-2}$	$4x10^{-7}$	$2x10^{-3}$
		I	$1x10^{-5}$	$6x10^{-2}$	$4x10^{-7}$	$2x10^{-3}$
Dysprosium (66)...........	Dy 165	S	$3x10^{-6}$	$1x10^{-2}$	$9x10^{-8}$	$4x10^{-4}$
		I	$2x10^{-6}$	$1x10^{-2}$	$7x10^{-8}$	$4x10^{-4}$
	Dy 166	S	$2x10^{-7}$	$1x10^{-3}$	$8x10^{-9}$	$4x10^{-5}$
		I	$2x10^{-7}$	$1x10^{-3}$	$7x10^{-9}$	$4x10^{-5}$
Einsteinium (99)...........	Es 253	S	$8x10^{-10}$	$7x10^{-4}$	$3x10^{-11}$	$2x10^{-5}$
		I	$6x10^{-10}$	$7x10^{-4}$	$2x10^{-11}$	$2x10^{-5}$
	Es 254 m	S	$5x10^{-9}$	$5x10^{-4}$	$2x10^{-10}$	$2x10^{-5}$
		I	$6x10^{-9}$	$5x10^{-4}$	$2x10^{-10}$	$2x10^{-5}$
	Es 254	S	$2x10^{-11}$	$4x10^{-4}$	$6x10^{-13}$	$1x10^{-5}$
		I	$1x10^{-10}$	$4x10^{-4}$	$4x10^{-12}$	$1x10^{-5}$
	Es 255	S	$5x10^{-10}$	$8x10^{-4}$	$2x10^{-11}$	$3x10^{-5}$
		I	$4x10^{-10}$	$8x10^{-4}$	$1x10^{-11}$	$3x10^{-5}$
Erbium (68)....................	Er 169	S	$6x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$9x10^{-5}$
		I	$4x10^{-7}$	$3x10^{-3}$	$1x10^{-8}$	$9x10^{-5}$
	Er 171	S	$7x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
		I	$6x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
Europium (63)...............	Eu 152	S	$4x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$6x10^{-5}$
	(T/2=9.2 hrs)	I	$3x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$6x10^{-5}$
	Eu 152	S	$1x10^{-8}$	$2x10^{-3}$	$4x10^{-10}$	$8x10^{-5}$
	(T/2=13 yrs)	I	$2x10^{-8}$	$2x10^{-3}$	$6x10^{-10}$	$8x10^{-5}$
	Eu 154	S	$4x10^{-9}$	$6x10^{-4}$	$1x10^{-10}$	$2x10^{-5}$
		I	$7x10^{-9}$	$6x10^{-4}$	$2x10^{-10}$	$2x10^{-5}$
	Eu 155	S	$9x10^{-8}$	$6x10^{-3}$	$3x10^{-9}$	$2x10^{-4}$
		I	$7x10^{-8}$	$6x10^{-3}$	$3x10^{-9}$	$2x10^{-4}$
Fermium (100)...............	Fm 254	S	$6x10^{-8}$	$4x10^{-3}$	$2x10^{-9}$	$1x10^{-4}$
		I	$7x10^{-8}$	$4x10^{-3}$	$2x10^{-9}$	$1x10^{-4}$
	Fm 255	S	$2x10^{-8}$	$1x10^{-3}$	$6x10^{-10}$	$3x10^{-5}$
		I	$1x10^{-8}$	$1x10^{-3}$	$4x10^{-10}$	$3x10^{-5}$
	Fm 256	S	$3x10^{-9}$	$3x10^{-5}$	$1x10^{-10}$	$9x10^{-7}$
		I	$2x10^{-9}$	$3x10^{-5}$	$6x10^{-11}$	$9x10^{-7}$

See footnotes at end of table.

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See Sec. C.4, C.17 and notes at end of appendix)

Element (atomic number)	Isotope[1]		TABLE I		TABLE II	
			Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
Fluorine (9)	F 18	S	$5x10^{-6}$	$2x10^{-2}$	$2x10^{-7}$	$8x10^{-4}$
		I	$3x10^{-6}$	$1x10^{-2}$	$9x10^{-8}$	$5x10^{-4}$
Gadolinium (64)	Gd 153	S	$2x10^{-7}$	$6x10^{-3}$	$8x10^{-9}$	$2x10^{-4}$
		I	$9x10^{-8}$	$6x10^{-3}$	$3x10^{-9}$	$2x10^{-4}$
	Gd 159	S	$5x10^{-7}$	$2x10^{-3}$	$2x10^{-8}$	$8x10^{-5}$
		I	$4x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$8x10^{-5}$
Gallium (31)	Ga 72	S	$2x10^{-7}$	$1x10^{-3}$	$8x10^{-9}$	$4x10^{-5}$
		I	$2x10^{-7}$	$1x10^{-3}$	$6x10^{-9}$	$4x10^{-5}$
Germanium (32)	Ge 71	S	$1x10^{-5}$	$5x10^{-2}$	$4x10^{-7}$	$2x10^{-3}$
		I	$6x10^{-6}$	$5x10^{-2}$	$2x10^{-7}$	$2x10^{-3}$
Gold (79)	Au 196	S	$1x10^{-6}$	$5x10^{-3}$	$4x10^{-8}$	$2x10^{-4}$
		I	$6x10^{-7}$	$4x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
	Au 198	S	$3x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$5x10^{-5}$
		I	$2x10^{-7}$	$1x10^{-3}$	$8x10^{-9}$	$5x10^{-5}$
	Au 199	S	$1x10^{-6}$	$5x10^{-3}$	$4x10^{-8}$	$2x10^{-4}$
		I	$8x10^{-7}$	$4x10^{-3}$	$3x10^{-8}$	$2x10^{-4}$
Hafnium (72)	Hf 181	S	$4x10^{-8}$	$2x10^{-3}$	$1x10^{-9}$	$7x10^{-5}$
		I	$7x10^{-8}$	$2x10^{-3}$	$3x10^{-9}$	$7x10^{-5}$
Holmium (67)	Ho 166	S	$2x10^{-7}$	$9x10^{-4}$	$7x10^{-9}$	$3x10^{-5}$
		I	$2x10^{-7}$	$9x10^{-4}$	$6x10^{-9}$	$3x10^{-5}$
Hydrogen (1)	H 3	S	$5x10^{-6}$	$1x10^{-1}$	$2x10^{-7}$	$3x10^{-3}$
		I	$5x10^{-6}$	$1x10^{-1}$	$2x10^{-7}$	$3x10^{-3}$
		Sub	$2x10^{-3}$	....	$4x10^{-5}$	....
Indium (49)	In 113 m	S	$8x10^{-6}$	$4x10^{-2}$	$3x10^{-7}$	$1x10^{-3}$
		I	$7x10^{-6}$	$4x10^{-2}$	$2x10^{-7}$	$1x10^{-3}$
	In 144 m	S	$1x10^{-7}$	$5x10^{-4}$	$4x10^{-9}$	$2x10^{-5}$
		I	$2x10^{-8}$	$5x10^{-4}$	$7x10^{-10}$	$2x10^{-5}$
	In 115 m	S	$2x10^{-6}$	$1x10^{-2}$	$8x10^{-8}$	$4x10^{-4}$
		I	$2x10^{-6}$	$1x10^{-2}$	$6x10^{-8}$	$4x10^{-4}$
	In 115	S	$2x10^{-7}$	$3x10^{-3}$	$9x10^{-9}$	$9x10^{-5}$
		I	$3x10^{-8}$	$3x10^{-3}$	$1x10^{-9}$	$9x10^{-5}$
Iodine (53)	*I 125	S	$5x10^{-9}$	$4x10^{-5}$	$8x10^{-11}$	$2x10^{-7}$
		I	$2x10^{-7}$	$6x10^{-3}$	$6x10^{-9}$	$2x10^{-4}$
	I 126	S	$8x10^{-9}$	$5x10^{-5}$	$9x10^{-11}$	$3x10^{-7}$
		I	$3x10^{-7}$	$3x10^{-3}$	$1x10^{-8}$	$9x10^{-5}$
	I 129	S	$2x10^{-9}$	$1x10^{-5}$	$2x10^{-11}$	$6x10^{-8}$
		I	$7x10^{-8}$	$6x10^{-3}$	$2x10^{-9}$	$2x10^{-4}$
	I 131	S	$9x10^{-9}$	$6x10^{-5}$	$1x10^{-10}$	$3x10^{-7}$
		I	$3x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$6x10^{-5}$
	I 132	S	$2x10^{-7}$	$2x10^{-3}$	$3x10^{-9}$	$8x10^{-6}$
		I	$9x10^{-7}$	$5x10^{-3}$	$3x10^{-8}$	$2x10^{-4}$
	I 133	S	$3x10^{-8}$	$2x10^{-4}$	$4x10^{-10}$	$1x10^{-6}$
		I	$2x10^{-7}$	$1x10^{-3}$	$7x10^{-9}$	$4x10^{-5}$
	I 134	S	$5x10^{-7}$	$4x10^{-3}$	$6x10^{-9}$	$2x10^{-5}$
		I	$3x10^{-6}$	$2x10^{-2}$	$1x10^{-7}$	$6x10^{-4}$
	I 135	S	$1x10^{-7}$	$7x10^{-4}$	$1x10^{-9}$	$4x10^{-6}$
		I	$4x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$7x10^{-5}$
Iridium (77)	Ir 190	S	$1x10^{-6}$	$6x10^{-3}$	$4x10^{-8}$	$2x10^{-4}$
		I	$4x10^{-7}$	$5x10^{-3}$	$1x10^{-8}$	$2x10^{-4}$
	Ir 192	S	$1x10^{-7}$	$1x10^{-3}$	$4x10^{-9}$	$4x10^{-5}$
		I	$3x10^{-8}$	$1x10^{-3}$	$9x10^{-10}$	$4x10^{-5}$

See footnotes at end of table.

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See Sec. C.4, C.17 and notes at end of appendix)

Element (atomic number)	Isotope[1]		TABLE I		TABLE II	
			Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
	Ir 194	S	2x10^{-7}	1x10^{-3}	8x10^{-9}	3x10^{-5}
		I	2x10^{-7}	9x10^{-4}	5x10^{-9}	3x10^{-5}
Iron (26)	Fe 55	S	9x10^{-7}	2x10^{-2}	3x10^{-8}	8x10^{-4}
		I	1x10^{-6}	7x10^{-2}	3x10^{-8}	2x10^{-3}
	Fe 59	S	1x10^{-7}	2x10^{-3}	5x10^{-9}	6x10^{-5}
		I	5x10^{-8}	2x10^{-3}	2x10^{-9}	5x10^{-5}
Krypton (36)	Kr 85 m	Sub	6x10^{-6}	....	1x10^{-7}	....
	Kr 85	Sub	1x10^{-5}	....	3x10^{-7}	....
	Kr 87	Sub	1x10^{-6}	....	2x10^{-8}	....
	Kr 88	Sub	1x10^{-6}	....	2x10^{-8}	....
Lanthanum (57)	La 140	S	2x10^{-7}	7x10^{-4}	5x10^{-9}	2x10^{-5}
		I	1x10^{-7}	7x10^{-4}	4x10^{-9}	2x10^{-5}
Lead (82)	Pb 203	S	3x10^{-6}	1x10^{-2}	9x10^{-8}	4x10^{-4}
		I	2x10^{-6}	1x10^{-2}	6x10^{-8}	4x10^{-4}
	Pb 210	S	1x10^{-10}	4x10^{-6}	4x10^{-12}	2x10^{-5}
		I	2x10^{-10}	5x10^{-3}	8x10^{-12}	2x10^{-4}
	Pb 212	S	2x10^{-8}	6x10^{-4}	6x10^{-10}	2x10^{-5}
		I	2x10^{-8}	5x10^{-4}	7x10^{-10}	1x10^{-7}
Lutetium (71)	Lu 177	S	6x10^{-7}	3x10^{-3}	2x10^{-8}	1x10^{-4}
		I	5x10^{-7}	3x10^{-3}	2x10^{-8}	1x10^{-4}
Manganese (25)	Mn 52	S	2x10^{-7}	1x10^{-3}	7x10^{-9}	3x10^{-5}
		I	1x10^{-7}	9x10^{-4}	5x10^{-9}	3x10^{-5}
	Mn 54	S	4x10^{-7}	4x10^{-3}	1x10^{-9}	1x10^{-4}
		I	4x10^{-8}	3x10^{-3}	1x10^{-9}	1x10^{-4}
	Mn 56	S	8x10^{-7}	4x10^{-3}	3x10^{-8}	1x10^{-4}
		I	5x10^{-7}	3x10^{-3}	2x10^{-8}	1x10^{-4}
Mercury (80)	Hg 197 m	S	7x10^{-7}	6x10^{-3}	3x10^{-8}	2x10^{-4}
		I	8x10^{-7}	5x10^{-3}	3x10^{-8}	2x10^{-4}
	Hg 197	S	1x10^{-6}	9x10^{-3}	4x10^{-8}	3x10^{-4}
		I	3x10^{-6}	1x10^{-2}	9x10^{-8}	5x10^{-4}
	Hg 203	S	7x10^{-8}	5x10^{-4}	2x10^{-9}	2x10^{-5}
		I	1x10^{-7}	3x10^{-3}	4x10^{-9}	1x10^{-4}
Molybdenum (42)	Mo 99	S	7x10^{-7}	5x10^{-3}	3x10^{-8}	2x10^{-4}
		I	2x10^{-7}	1x10^{-3}	7x10^{-9}	4x10^{-5}
Neodymium (60)	Nd 144	S	8x10^{-11}	2x10^{-3}	3x10^{-12}	7x10^{-5}
		I	3x10^{-10}	2x10^{-3}	1x10^{-11}	8x10^{-5}
	Nd 147	S	4x10^{-7}	2x10^{-3}	1x10^{-8}	6x10^{-5}
		I	2x10^{-7}	2x10^{-3}	8x10^{-9}	6x10^{-5}
	Nd 149	S	2x10^{-6}	8x10^{-3}	6x10^{-8}	3x10^{-4}
		I	1x10^{-6}	8x10^{-3}	5x10^{-8}	3x10^{-4}
Neptunium (93)	Np 237	S	4x10^{-12}	9x10^{-5}	1x10^{-13}	3x10^{-6}
		I	1x10^{-10}	9x10^{-4}	4x10^{-12}	3x10^{-5}
	Np 239	S	8x10^{-7}	4x10^{-3}	3x10^{-8}	1x10^{-4}
		I	7x10^{-7}	4x10^{-3}	2x10^{-8}	1x10^{-4}
Nickel (28)	Ni 59	S	5x10^{-7}	6x10^{-3}	2x10^{-8}	2x10^{-4}
		I	8x10^{-7}	6x10^{-2}	3x10^{-8}	2x10^{-3}
	Ni 63	S	6x10^{-8}	8x10^{-4}	2x10^{-9}	3x10^{-5}
		I	3x10^{-7}	2x10^{-2}	1x10^{-8}	7x10^{-4}
	Ni 65	S	9x10^{-7}	4x10^{-3}	3x10^{-8}	1x10^{-4}
		I	5x10^{-7}	3x10^{-3}	2x10^{-8}	1x10^{-4}
Niobium (Columbium) (41)	Nb 93 m	S	1x10^{-7}	1x10^{-2}	4x10^{-9}	4x10^{-4}
		I	2x10^{-7}	1x10^{-2}	5x10^{-9}	4x10^{-4}

See footnotes at end of table.

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See Sec. C.4, C.17 and notes at end of appendix)

Element (atomic number)	Isotope[1]		TABLE 1		TABLE II	
			Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
	Nb 95	S	$5x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
		I	$1x10^{-7}$	$3x10^{-3}$	$3x10^{-9}$	$1x10^{-4}$
	Nb 97	S	$6x10^{-6}$	$3x10^{-2}$	$2x10^{-7}$	$9x10^{-4}$
		I	$5x10^{-6}$	$3x10^{-2}$	$2x10^{-7}$	$9x10^{-4}$
Osmium (76)	Os 185	S	$5x10^{-7}$	$2x10^{-3}$	$2x10^{-8}$	$7x10^{-5}$
		I	$5x10^{-8}$	$2x10^{-3}$	$2x10^{-9}$	$7x10^{-5}$
	Os 191 m	S	$2x10^{-5}$	$7x10^{-2}$	$6x10^{-7}$	$3x10^{-3}$
		I	$9x10^{-6}$	$7x10^{-2}$	$3x10^{-7}$	$2x10^{-3}$
	Os 191	S	$1x10^{-6}$	$5x10^{-3}$	$4x10^{-8}$	$2x10^{-4}$
		I	$4x10^{-7}$	$5x10^{-3}$	$1x10^{-8}$	$2x10^{-4}$
	Os 193	S	$4x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$6x10^{-5}$
		I	$3x10^{-7}$	$2x10^{-3}$	$9x10^{-9}$	$5x10^{-5}$
Palladium (46)	Pd 103	S	$1x10^{-6}$	$1x10^{-2}$	$5x10^{-8}$	$3x10^{-4}$
		I	$7x10^{-7}$	$8x10^{-3}$	$3x10^{-8}$	$3x10^{-4}$
	Pd 109	S	$6x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$9x10^{-5}$
		I	$4x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$7x10^{-5}$
Phosphorus (15)	P 32	S	$7x10^{-8}$	$5x10^{-4}$	$2x10^{-9}$	$2x10^{-5}$
		I	$8x10^{-8}$	$7x10^{-4}$	$3x10^{-9}$	$2x10^{-5}$
Platinum (78)	Pt 191	S	$8x10^{-7}$	$4x10^{-3}$	$3x10^{-8}$	$1x10^{-4}$
		I	$6x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
	Pt 193 m	S	$7x10^{-6}$	$3x10^{-2}$	$2x10^{-7}$	$1x10^{-3}$
		I	$5x10^{-6}$	$3x10^{-2}$	$2x10^{-7}$	$1x10^{-3}$
	Pt 197 m	S	$6x10^{-6}$	$3x10^{-2}$	$2x10^{-7}$	$1x10^{-3}$
		I	$5x10^{-6}$	$3x10^{-2}$	$2x10^{-7}$	$9x10^{-4}$
	Pt 197	S	$8x10^{-7}$	$4x10^{-3}$	$3x10^{-8}$	$1x10^{-4}$
		I	$6x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
Plutonium (94)	Pu 238	S	$2x10^{-12}$	$1x10^{-4}$	$7x10^{-14}$	$5x10^{-6}$
		I	$3x10^{-11}$	$8x10^{-4}$	$1x10^{-12}$	$3x10^{-5}$
	Pu 239	S	$2x10^{-12}$	$1x10^{-4}$	$6x10^{-14}$	$5x10^{-6}$
		I	$4x10^{-11}$	$8x10^{-4}$	$1x10^{-12}$	$3x10^{-5}$
	Pu 240	S	$2x10^{-12}$	$1x10^{-4}$	$6x10^{-14}$	$5x10^{-6}$
		I	$4x10^{-11}$	$8x10^{-4}$	$1x10^{-12}$	$3x10^{-5}$
	Pu 241	S	$9x10^{-11}$	$7x10^{-3}$	$3x10^{-12}$	$2x10^{-4}$
		I	$4x10^{-8}$	$4x10^{-2}$	$1x10^{-9}$	$1x10^{-3}$
	Pu 242	S	$2x10^{-12}$	$1x10^{-4}$	$6x10^{-14}$	$5x10^{-6}$
		I	$4x10^{-11}$	$9x10^{-4}$	$1x10^{-12}$	$3x10^{-5}$
	Pu 243	S	$2x10^{-6}$	$1x10^{-2}$	$6x10^{-8}$	$3x10^{-4}$
		I	$2x10^{-6}$	$1x10^{-2}$	$8x10^{-8}$	$3x10^{-4}$
	Pu 244	S	$2x10^{-12}$	$1x10^{-4}$	$6x10^{-14}$	$4x10^{-6}$
		I	$3x10^{-11}$	$3x10^{-4}$	$1x10^{-12}$	$1x10^{-5}$
Polonium (84)	Po 210	S	$5x10^{-10}$	$2x10^{-5}$	$2x10^{-11}$	$7x10^{-7}$
		I	$2x10^{-10}$	$8x10^{-4}$	$7x10^{-12}$	$3x10^{-5}$
Potassium (19)	K 42	S	$2x10^{-6}$	$9x10^{-3}$	$7x10^{-8}$	$3x10^{-4}$
		I	$1x10^{-7}$	$6x10^{-4}$	$4x10^{-9}$	$2x10^{-5}$
Praseodymium (59)	Pr 142	S	$2x10^{-7}$	$9x10^{-4}$	$7x10^{-9}$	$3x10^{-5}$
		I	$2x10^{-7}$	$9x10^{-4}$	$5x10^{-9}$	$3x10^{-5}$
	Pr 143	S	$3x10^{-7}$	$1x10^{-3}$	$1x10^{-8}$	$5x10^{-5}$
		I	$2x10^{-7}$	$1x10^{-3}$	$6x10^{-9}$	$5x10^{-5}$
Promethium (61)	Pm 147	S	$6x10^{-8}$	$6x10^{-3}$	$2x10^{-9}$	$2x10^{-4}$
		I	$1x10^{-7}$	$6x10^{-3}$	$3x10^{-9}$	$2x10^{-4}$
	Pm 149	S	$3x10^{-7}$	$1x10^{-3}$	$1x10^{-8}$	$4x10^{-5}$
		I	$2x10^{-7}$	$1x10^{-3}$	$8x10^{-9}$	$4x10^{-5}$

See footnotes at end of table.

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See Sec. C.4, C.17 and notes at end of appendix)

Element (atomic number)	Isotope[1]		TABLE I Column 1 Air (uc/ml)	TABLE I Column 2 Water (uc/ml)	TABLE II Column 1 Air (uc/ml)	TABLE II Column 2 Water (uc/ml)
Protoactinium (91)......	Pa 230	S	2x10^{-9}	7x10^{-3}	6x10^{-11}	2x10^{-4}
		I	8x10^{-10}	7x10^{-3}	3x10^{-11}	2x10^{-4}
	Pa 231	S	1x10^{-12}	3x10^{-5}	4x10^{-14}	9x10^{-7}
		I	1x10^{-10}	8x10^{-4}	4x10^{-12}	2x10^{-5}
	Pa 233	S	6x10^{-7}	4x10^{-3}	2x10^{-8}	1x10^{-4}
		I	2x10^{-7}	3x10^{-3}	6x10^{-9}	1x10^{-4}
Radium (88)..................	Ra 223	S	2x10^{-9}	2x10^{-5}	6x10^{-11}	7x10^{-7}
		I	2x10^{-10}	1x10^{-4}	8x10^{-12}	4x10^{-6}
	Ra 224	S	5x10^{-9}	7x10^{-5}	2x10^{-10}	2x10^{-6}
		I	7x10^{-10}	2x10^{-4}	2x10^{-11}	5x10^{-6}
	Ra 226	S	3x10^{-11}	4x10^{-7}	3x10^{-12}	3x10^{-8}
		I	5x10^{-11}	9x10^{-4}	2x10^{-12}	3x10^{-5}
	Ra 228	S	7x10^{-11}	8x10^{-7}	2x10^{-12}	3x10^{-8}
		I	4x10^{-11}	7x10^{-4}	1x10^{-12}	3x10^{-5}
Radon (86).....................	Rn 220	S	3x10^{-7}	....	1x10^{-8}	....
		I	....	....	....	....
	Rn 222	S	1x10^{-7}	....	3x10^{-9}	....
Rhenium (75)................	Re 183	S	3x10^{-6}	2x10^{-2}	9x10^{-8}	6x10^{-4}
		I	2x10^{-7}	8x10^{-3}	5x10^{-9}	3x10^{-4}
	Re 186	S	6x10^{-7}	3x10^{-3}	2x10^{-8}	9x10^{-5}
		I	2x10^{-7}	1x10^{-3}	8x10^{-9}	5x10^{-5}
	Re 187	S	9x10^{-6}	7x10^{-2}	3x10^{-7}	3x10^{-3}
		I	5x10^{-7}	4x10^{-2}	2x10^{-8}	2x10^{-3}
	Re 188	S	4x10^{-7}	2x10^{-3}	1x10^{-8}	6x10^{-5}
		I	2x10^{-7}	9x10^{-4}	6x10^{-9}	3x10^{-5}
Rhodium (45)................	Rh 103 m	S	8x10^{-5}	4x10^{-1}	3x10^{-6}	1x10^{-2}
		I	6x10^{-5}	3x10^{-1}	2x10^{-6}	1x10^{-2}
	Rh 105	S	8x10^{-7}	4x10^{-3}	3x10^{-8}	1x10^{-4}
		I	5x10^{-7}	3x10^{-3}	2x10^{-8}	1x10^{-4}
Rubidium (37)..............	Rb 86	S	3x10^{-7}	2x10^{-3}	1x10^{-8}	7x10^{-5}
		I	7x10^{-8}	7x10^{-4}	2x10^{-9}	2x10^{-5}
	Rb 87	S	5x10^{-7}	3x10^{-3}	2x10^{-8}	1x10^{-4}
		I	7x10^{-8}	5x10^{-3}	2x10^{-9}	2x10^{-4}
Ruthenium (44)............	Ru 97	S	2x10^{-6}	1x10^{-2}	8x10^{-8}	4x10^{-4}
		I	2x10^{-6}	1x10^{-2}	6x10^{-8}	3x10^{-4}
	Ru 103	S	5x10^{-7}	2x10^{-3}	2x10^{-8}	8x10^{-5}
		I	8x10^{-8}	2x10^{-3}	3x10^{-9}	8x10^{-5}
	Ru 105	S	7x10^{-7}	3x10^{-3}	2x10^{-8}	1x10^{-4}
		I	5x10^{-7}	3x10^{-3}	2x10^{-8}	1x10^{-4}
	Ru 106	S	8x10^{-8}	4x10^{-4}	3x10^{-9}	1x10^{-5}
		I	6x10^{-9}	3x10^{-4}	2x10^{-10}	1x10^{-5}
Samarium (62).............	Sm 147	S	7x10^{-11}	2x10^{-3}	2x10^{-12}	6x10^{-5}
		I	3x10^{-10}	2x10^{-3}	9x10^{-12}	7x10^{-5}
	Sm 151	S	6x10^{-8}	1x10^{-2}	2x10^{-9}	4x10^{-4}
		I	1x10^{-7}	1x10^{-2}	5x10^{-9}	4x10^{-4}
	Sm 153	S	5x10^{-7}	2x10^{-3}	2x10^{-8}	8x10^{-5}
		I	4x10^{-7}	2x10^{-3}	1x10^{-8}	8x10^{-5}
Scandium (21)..............	Sc 46	S	2x10^{-7}	1x10^{-3}	8x10^{-9}	4x10^{-5}
		I	2x10^{-8}	1x10^{-3}	8x10^{-10}	4x10^{-5}
	Sc 47	S	6x10^{-7}	3x10^{-3}	2x10^{-8}	9x10^{-5}
		I	5x10^{-7}	3x10^{-3}	2x10^{-8}	9x10^{-5}

See footnotes at end of table.

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See Sec. C.4, C.17 and notes at end of appendix)

Element (atomic number)	Isotope[1]		TABLE I		TABLE II	
			Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
	Sc 48	S	$2x10^{-7}$	$8x10^{-4}$	$6x10^{-9}$	$3x10^{-5}$
		I	$1x10^{-7}$	$8x10^{-4}$	$5x10^{-9}$	$3x10^{-5}$
Selenium (34)	Se 75	S	$1x10^{-6}$	$9x10^{-3}$	$4x10^{-8}$	$3x10^{-4}$
		I	$1x10^{-7}$	$8x10^{-3}$	$4x10^{-9}$	$3x10^{-4}$
Silicon (14)	Si 31	S	$6x10^{-6}$	$3x10^{-2}$	$2x10^{-7}$	$9x10^{-4}$
		I	$1x10^{-6}$	$6x10^{-3}$	$3x10^{-8}$	$2x10^{-4}$
Silver (47)	Ag 105	S	$6x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
		I	$8x10^{-8}$	$3x10^{-3}$	$3x10^{-9}$	$1x10^{-4}$
	Ag 110 m	S	$2x10^{-7}$	$9x10^{-4}$	$7x10^{-9}$	$3x10^{-5}$
		I	$1x10^{-8}$	$9x10^{-4}$	$3x10^{-10}$	$3x10^{-5}$
	Ag 111	S	$3x10^{-7}$	$1x10^{-3}$	$1x10^{-8}$	$4x10^{-5}$
		I	$2x10^{-7}$	$1x10^{-3}$	$8x10^{-9}$	$4x10^{-5}$
Sodium (11)	Na 22	S	$2x10^{-7}$	$1x10^{-3}$	$6x10^{-9}$	$4x10^{-5}$
		I	$9x10^{-9}$	$9x10^{-4}$	$3x10^{-10}$	$3x10^{-5}$
	Na 24	S	$1x10^{-6}$	$6x10^{-3}$	$4x10^{-8}$	$2x10^{-4}$
		I	$1x10^{-7}$	$8x10^{-4}$	$5x10^{-9}$	$3x10^{-5}$
Strontium (38)	Sr 85 m	S	$4x10^{-5}$	$2x10^{-1}$	$1x10^{-6}$	$7x10^{-3}$
		I	$3x10^{-5}$	$2x10^{-1}$	$1x10^{-6}$	$7x10^{-3}$
	Sr 85	S	$2x10^{-7}$	$3x10^{-3}$	$8x10^{-9}$	$1x10^{-4}$
		I	$1x10^{-7}$	$5x10^{-3}$	$4x10^{-9}$	$2x10^{-4}$
	Sr 89	S	$3x10^{-8}$	$3x10^{-4}$	$3x10^{-10}$	$3x10^{-6}$
		I	$4x10^{-8}$	$8x10^{-4}$	$1x10^{-9}$	$3x10^{-5}$
	Sr 90	S	$1x10^{-9}$	$1x10^{-5}$	$3x10^{-11}$	$3x10^{-7}$
		I	$5x10^{-9}$	$1x10^{-3}$	$2x10^{-10}$	$4x10^{-5}$
	Sr 91	S	$4x10^{-7}$	$2x10^{-3}$	$2x10^{-8}$	$7x10^{-5}$
		I	$3x10^{-7}$	$1x10^{-3}$	$9x10^{-9}$	$5x10^{-5}$
	Sr 92	S	$4x10^{-7}$	$2x10^{-3}$	$2x10^{-8}$	$7x10^{-5}$
		I	$3x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$6x10^{-5}$
Sulfur (16)	S 35	S	$3x10^{-7}$	$2x10^{-3}$	$9x10^{-9}$	$6x10^{-5}$
		I	$3x10^{-7}$	$8x10^{-3}$	$9x10^{-9}$	$3x10^{-4}$
Tantalum (73)	Ta 182	S	$4x10^{-8}$	$1x10^{-3}$	$1x10^{-9}$	$4x10^{-5}$
		I	$2x10^{-8}$	$1x10^{-3}$	$7x10^{-10}$	$4x10^{-5}$
Technetium (43)	Tc 96 m	S	$8x10^{-5}$	$4x10^{-1}$	$3x10^{-6}$	$1x10^{-2}$
		I	$3x10^{-5}$	$3x10^{-1}$	$1x10^{-6}$	$1x10^{-2}$
	Tc 96	S	$6x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
		I	$2x10^{-7}$	$1x10^{-3}$	$8x10^{-9}$	$5x10^{-5}$
	Tc 97 m	S	$2x10^{-6}$	$1x10^{-2}$	$8x10^{-8}$	$4x10^{-4}$
		I	$2x10^{-7}$	$5x10^{-3}$	$5x10^{-9}$	$2x10^{-4}$
	Tc 97	S	$1x10^{-5}$	$5x10^{-2}$	$4x10^{-7}$	$2x10^{-3}$
		I	$3x10^{-7}$	$2x10^{-2}$	$1x10^{-8}$	$8x10^{-4}$
	Tc 99 m	S	$4x10^{-5}$	$2x10^{-1}$	$1x10^{-6}$	$6x10^{-3}$
		I	$1x10^{-5}$	$8x10^{-2}$	$5x10^{-7}$	$3x10^{-3}$
	Tc 99	S	$2x10^{-6}$	$1x10^{-2}$	$7x10^{-8}$	$3x10^{-4}$
		I	$6x10^{-8}$	$5x10^{-3}$	$2x10^{-9}$	$2x10^{-4}$
Tellurium (52)	Te 125 m	S	$4x10^{-7}$	$5x10^{-3}$	$1x10^{-8}$	$2x10^{-4}$
		I	$1x10^{-7}$	$3x10^{-3}$	$4x10^{-9}$	$1x10^{-4}$
	Te 127 m	S	$1x10^{-7}$	$2x10^{-3}$	$5x10^{-9}$	$6x10^{-5}$
		I	$4x10^{-8}$	$2x10^{-3}$	$1x10^{-9}$	$5x10^{-5}$
	Te 127	S	$2x10^{-6}$	$8x10^{-3}$	$6x10^{-8}$	$3x10^{-4}$
		I	$9x10^{-7}$	$5x10^{-3}$	$3x10^{-8}$	$2x10^{-4}$
	Te 129 m	S	$8x10^{-8}$	$1x10^{-3}$	$3x10^{-9}$	$3x10^{-5}$
		I	$3x10^{-8}$	$6x10^{-4}$	$1x10^{-9}$	$2x10^{-5}$

See footnotes at end of table.

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See Sec. C.4, C.17 and notes at end of appendix)

Element (atomic number)	Isotope[1]		TABLE I		TABLE II	
			Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
	Te 129	S	$5x10^{-6}$	$2x10^{-2}$	$2x10^{-7}$	$8x10^{-4}$
		I	$4x10^{-6}$	$2x10^{-2}$	$1x10^{-7}$	$8x10^{-4}$
	Te 131 m	S	$4x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$6x10^{-5}$
		I	$2x10^{-7}$	$1x10^{-3}$	$6x10^{-9}$	$4x10^{-5}$
	Te 132	S	$2x10^{-7}$	$9x10^{-4}$	$7x10^{-9}$	$3x10^{-5}$
		I	$1x10^{-7}$	$6x10^{-4}$	$4x10^{-9}$	$2x10^{-5}$
Terbium (65)..................	Tb 160	S	$1x10^{-7}$	$1x10^{-3}$	$3x10^{-9}$	$4x10^{-5}$
		I	$3x10^{-8}$	$1x10^{-3}$	$1x10^{-9}$	$4x10^{-5}$
Thallium (81).................	Tl 200	S	$3x10^{-6}$	$1x10^{-2}$	$9x10^{-8}$	$4x10^{-4}$
		I	$1x10^{-6}$	$7x10^{-3}$	$4x10^{-8}$	$2x10^{-4}$
	Tl 201	S	$2x10^{-6}$	$9x10^{-3}$	$7x10^{-8}$	$3x10^{-4}$
		I	$9x10^{-7}$	$5x10^{-3}$	$3x10^{-8}$	$2x10^{-4}$
	Tl 202	S	$8x10^{-7}$	$4x10^{-3}$	$3x10^{-8}$	$1x10^{-4}$
		I	$2x10^{-7}$	$2x10^{-3}$	$8x10^{-9}$	$7x10^{-5}$
	Tl 204	S	$6x10^{-7}$	$3x10^{-3}$	$2x10^{-8}$	$1x10^{-4}$
		I	$3x10^{-8}$	$2x10^{-3}$	$9x10^{-10}$	$6x10^{-5}$
Thorium (90)..................	Th 228	S	$9x10^{-12}$	$2x10^{-4}$	$3x10^{-13}$	$7x10^{-6}$
		I	$6x10^{-12}$	$4x10^{-4}$	$2x10^{-13}$	$1x10^{-5}$
	Th 230	S	$2x10^{-12}$	$5x10^{-5}$	$8x10^{-14}$	$2x10^{-6}$
		I	$1x10^{-11}$	$9x10^{-4}$	$3x10^{-13}$	$3x10^{-5}$
	Th 232	S	$3x10^{-11}$	$5x10^{-5}$	$1x10^{-12}$	$2x10^{-6}$
		I	$3x10^{-11}$	$1x10^{-3}$	$1x10^{-12}$	$4x10^{-5}$
	Th natural	S	$3x10^{-11}$	$3x10^{-5}$	$1x10^{-12}$	$1x10^{-6}$
		I	$3x10^{-11}$	$3x10^{-4}$	$1x10^{-12}$	$1x10^{-5}$
	Th 234	S	$6x10^{-8}$	$5x10^{-4}$	$2x10^{-9}$	$2x10^{-5}$
		I	$3x10^{-8}$	$5x10^{-4}$	$1x10^{-9}$	$2x10^{-5}$
Thulium (69)..................	Tm 170	S	$4x10^{-8}$	$1x10^{-3}$	$1x10^{-9}$	$5x10^{-5}$
		I	$3x10^{-8}$	$1x10^{-3}$	$1x10^{-9}$	$5x10^{-5}$
	Tm 171	S	$1x10^{-7}$	$1x10^{-2}$	$4x10^{-9}$	$5x10^{-4}$
		I	$2x10^{-7}$	$1x10^{-2}$	$8x10^{-9}$	$5x10^{-4}$
Tin (50).........................	Sn 113	S	$4x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$9x10^{-5}$
		I	$5x10^{-8}$	$2x10^{-3}$	$2x10^{-9}$	$8x10^{-5}$
	Sn 125	S	$1x10^{-7}$	$5x10^{-4}$	$4x10^{-9}$	$2x10^{-5}$
		I	$8x10^{-8}$	$5x10^{-4}$	$3x10^{-9}$	$2x10^{-5}$
Tungsten (Wolfram) (74).........	W 181	S	$2x10^{-6}$	$1x10^{-2}$	$8x10^{-8}$	$4x10^{-4}$
		I	$1x10^{-7}$	$1x10^{-2}$	$4x10^{-9}$	$3x10^{-4}$
	W 185	S	$8x10^{-7}$	$4x10^{-3}$	$3x10^{-8}$	$1x10^{-4}$
		I	$1x10^{-7}$	$3x10^{-3}$	$4x10^{-9}$	$1x10^{-4}$
	W 187	S	$4x10^{-7}$	$2x10^{-3}$	$2x10^{-8}$	$7x10^{-5}$
		I	$3x10^{-7}$	$2x10^{-3}$	$1x10^{-8}$	$6x10^{-5}$
Uranium (92)................	U 230	S	$3x10^{-10}$	$1x10^{-4}$	$1x10^{-11}$	$5x10^{-6}$
		I	$1x10^{-10}$	$1x10^{-4}$	$4x10^{-12}$	$5x10^{-6}$
	U 232	S	$1x10^{-10}$	$8x10^{-4}$	$3x10^{-12}$	$3x10^{-5}$
		I	$3x10^{-11}$	$8x10^{-4}$	$9x10^{-13}$	$3x10^{-5}$
	U 233	S	$5x10^{-10}$	$9x10^{-4}$	$2x10^{-11}$	$3x10^{-5}$
		I	$1x10^{-10}$	$9x10^{-4}$	$4x10^{-12}$	$3x10^{-5}$
	U 234	S	$6x10^{-10}$	$9x10^{-4}$	$2x10^{-11}$	$3x10^{-5}$
		I	$1x10^{-10}$	$9x10^{-4}$	$4x10^{-12}$	$3x10^{-5}$
	U 235	S	$5x10^{-10}$	$8x10^{-4}$	$2x10^{-11}$	$3x10^{-5}$
		I	$1x10^{-10}$	$8x10^{-4}$	$4x10^{-12}$	$3x10^{-5}$
	U 236	S	$6x10^{-10}$	$1x10^{-3}$	$2x10^{-11}$	$3x10^{-5}$
		I	$1x10^{-10}$	$1x10^{-3}$	$4x10^{-12}$	$3x10^{-5}$

See footnotes at end of table.

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See Sec. C.4, C.17 and notes at end of appendix)

Element (atomic number)	Isotope[1]		TABLE I		TABLE II	
			Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
	U 238	S	7×10^{-11}	1×10^{-3}	3×10^{-12}	4×10^{-5}
		I	1×10^{-10}	1×10^{-3}	5×10^{-12}	4×10^{-5}
	U 240	S	2×10^{-7}	1×10^{-3}	8×10^{-9}	3×10^{-5}
		I	2×10^{-7}	1×10^{-3}	6×10^{-9}	3×10^{-5}
	U natural	S	7×10^{-11}	5×10^{-4}	3×10^{-12}	2×10^{-5}
		I	6×10^{-11}	5×10^{-4}	2×10^{-12}	2×10^{-5}
Vanadium (23)............	V 48	S	2×10^{-7}	9×10^{-4}	6×10^{-9}	3×10^{-5}
		I	6×10^{-8}	8×10^{-4}	2×10^{-9}	3×10^{-5}
Xenon (54).....................	Xe 131 m	Sub	2×10^{-5}	....	4×10^{-7}	....
	Xe 133 m	Sub	1×10^{-5}	....	3×10^{-7}	....
	Xe 133	Sub	1×10^{-5}	....	3×10^{-7}	....
	Xe 135	Sub	4×10^{-6}	....	1×10^{-7}	....
Ytterbium (70)............	Yb 175	S	7×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
		I	6×10^{-7}	3×10^{-3}	2×10^{-8}	1×10^{-4}
Yttrium (39).................	Y 90	S	1×10^{-7}	6×10^{-4}	4×10^{-9}	2×10^{-5}
		I	1×10^{-7}	6×10^{-4}	3×10^{-9}	2×10^{-5}
	Y 91 m	S	2×10^{-5}	1×10^{-1}	8×10^{-7}	3×10^{-3}
		I	2×10^{-5}	1×10^{-1}	6×10^{-7}	3×10^{-3}
	Y 91	S	4×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
		I	3×10^{-8}	8×10^{-4}	1×10^{-9}	3×10^{-5}
	Y 92	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Y 93	S	2×10^{-7}	8×10^{-4}	6×10^{-9}	3×10^{-5}
		I	1×10^{-7}	8×10^{-4}	5×10^{-9}	3×10^{-5}
Zinc (30)........................	Zn 65	S	1×10^{-7}	3×10^{-3}	4×10^{-9}	1×10^{-4}
		I	6×10^{-8}	5×10^{-3}	2×10^{-9}	2×10^{-4}
	Zn 69 m	S	4×10^{-7}	2×10^{-3}	1×10^{-8}	7×10^{-5}
		I	3×10^{-7}	2×10^{-3}	1×10^{-8}	6×10^{-5}
	Zn 69	S	7×10^{-6}	5×10^{-2}	2×10^{-7}	2×10^{-3}
		I	9×10^{-6}	5×10^{-2}	3×10^{-7}	2×10^{-3}
Zirconium (40)............	Zr 93	S	1×10^{-7}	2×10^{-2}	4×10^{-9}	8×10^{-4}
		I	3×10^{-7}	2×10^{-2}	1×10^{-8}	8×10^{-4}
	Zr 95	S	1×10^{-7}	2×10^{-3}	4×10^{-9}	6×10^{-5}
		I	3×10^{-8}	2×10^{-3}	1×10^{-9}	6×10^{-5}
	Zr 97	S	1×10^{-7}	5×10^{-4}	4×10^{-9}	2×10^{-5}
		I	9×10^{-8}	5×10^{-4}	3×10^{-9}	2×10^{-5}
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with radioactive half-life less than 2 hours.		Sub	1×10^{-6}	....	3×10^{-8}	....
Any single radionuclide not listed above with decay mode other than alpha emission or spontaneous fission and with			3×10^{-9}	9×10^{-5}	1×10^{-10}	3×10^{-6}

See footnotes at end of table.

APPENDIX A

CONCENTRATIONS IN AIR AND WATER ABOVE NATURAL BACKGROUND

(See Sec. C.4, C.17 and notes at end of appendix)

Element (atomic number)	Isotope[1]	TABLE I		TABLE II	
		Column 1 Air (uc/ml)	Water (uc/ml) Column 2	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
radioactive half-life greater than 2 hours.					
Any single radionuclide not listed above, which decays by alpha emission or spontaneous fission.		$6x10^{-13}$	$4x10^{-7}$	$2x10^{-14}$	$3x10^{-8}$

---

[1] Soluble (S); Insoluble (I).

[2] "Sub" means that values given are for submersion in a semi-spherical infinite cloud of airborne material.

APPENDIX A

NOTE: In any case where there is a mixture in air or water of more than one radionuclide, the limiting values for purposes of this Appendix should be determined as follows:

1. If the identity and concentration of each radionuclide in the mixture are known, the limiting values should be derived as follows: Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the limit otherwise established in Appendix "A" for the specific radionuclide when not in a mixture. The sum of such ratios for all the radionuclides in the mixture may not exceed "1" (i.e., "unity").

EXAMPLE: If radionuclides a, b, and c are present in concentrations C_a, C_b, and C_c, and if the applicable MPC's are MPC_a, MPC_b, and MPC_c, respectively, then the concentrations shall be limited so that the following relationship exists:

$$\frac{C_a}{MPC_a} + \frac{C_b}{MPC_b} + \frac{C_c}{MPC_c} \leqq 1$$

2. If either the identity or the concentration of any radionuclide in the mixture is not known, the limiting values for purposes of Appendix "A" shall be:

a. For purposes of Table I, Col. 1................................$6x10^{-13}$

b. For purposes of Table I, Col. 2................................$4x10^{-7}$

c. For purposes of Table II, Col. 1................................$2x10^{-14}$

d. For purposes of Table II, Col. 2................................$3x10^{-8}$

3. If any of the conditions specified below are met, the corresponding values specified below may be used in lieu of those specified in paragraph 2 above.

APPENDIX A

a. If the identity of each radionuclide in the mixture is known but the concentration of one or more of the radionuclides in the mixture is not known, the concentration limit for the mixture is the limit specified in Appendix "A" for the radionuclide in the mixture having the lowest concentration limit; or,

b. If the identity of each radionuclide in the mixture is not known, but it is known that certain radionuclides specified in Appendix "A" are not present in the mixture, the concentration limit for the mixture is the lowest concentration limit specified in Appendix "A" for any radionuclide which is not known to be absent from the mixture; or,

	TABLE I		TABLE II	
c. Element (atomic number) and isotope	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)	Column 1 Air (uc/ml)	Column 2 Water (uc/ml)
If it is known that Sr 90, I 125, I 126, I 129, I 131, (I 133, Table II only), Pb 210, Po 210, At 211, Ra 223, Ra 224, Ra 226, Ac 227, Ra 228, Th 230, Pa 231, Th 232, Th-nat, Cm 248, Cf 254, and Fm 256 are not present	....	$9\text{x}10^{-5}$	....	$3\text{x}10^{-6}$
If it is known that Sr 90, I 125, I 126, I 129, (I 131, I 133, Table II only), Pb 210, Po 210, Ra 223, Ra 226, Ra 228, Pa 231, Th-nat, Cm 248, Cf 254, and Fm 256 are not present	....	$6\text{x}10^{-5}$	....	$2\text{x}10^{-6}$
If it is known that Sr 90, I 129, (I 125, I 126, I 131, Table II only), Pb 210, Ra 226, Ra 228, Cm 248, and Cf 254 are not present	....	$2\text{x}10^{-5}$	....	$6\text{x}10^{-7}$
If it is known that (I 129, Table II only), Ra 226, and Ra 228 are not present	....	$3\text{x}10^{-6}$	....	$1\text{x}10^{-7}$
If it is known that alpha-emitters and Sr 90, I 129, Pb 210, Ac 227, Ra 228, Pa 230, Pu 241, and Bk 249 are not present	$3\text{x}10^{-9}$	....	$1\text{x}10^{-10}$	....
If it is known that alpha-emitters and Pb 210, Ac 227, Ra 228, and Pu 241 are not present	$3\text{x}10^{-10}$	....	$1\text{x}10^{-11}$	....
If it is known that alpha-emitters and Ac 227 are not present	$3\text{x}10^{-11}$	....	$1\text{x}10^{-12}$	....
If it is known that Ac 227, Th 230, Pa 231, Pu 238, Pu 239, Pu 240, Pu 242. Pu 244, Cm 248, Cf 249 and Cf 251 are not present	$3\text{x}10^{-12}$	....	$1\text{x}10^{-13}$	....

4. If the mixture of radioculides consists of uranium and its daughter products in ore dust prior to chemical processing of the uranium ore, the values specified below may be used in lieu of those determined in accordance with paragraph 1 above or those specified in paragraphs 2 and 3 above.

a. For purposes of Table I, Column 1, $1\text{x}10^{-10}$ uc/ml gross alpha activity; or $2.5\text{x}10^{-11}$ uc/ml natural uranium; or 75 micrograms per cubic meter of air natural uranium.

b. For purposes of Table II, Column 1, $3\text{x}10^{-12}$ uc/ml gross alpha activity; or $8\text{x}10^{-13}$ uc/ml natural uranium; or 3 micrograms per cubic meter of air natural uranium.

5. For purposes of this note, a radionuclide may be considered as not present in a mixture if (a) the ratio of the concentration of that radionuclide in the mixture (C_a) to the concentration limit for that radionuclide specified in Table II of Appendix "A" (MPC_a) does not exceed 1/10, (i.e., $\frac{C_a}{MPC_a} \leqq \frac{1}{10}$) and (b) the sum of such ratios for all radionuclides considered as not present in the mixture does not exceed 1/4, (i.e., $\frac{C_a}{MPC_a} + \frac{C_b}{MPC_b} + \ldots \leqq \frac{1}{4}$).

Part C

APPENDIX B

POSTING AND DISPOSAL REFERENCES

(See Section C. 11 (f) (3))

Material	Microcuries	Material	Microcuries
Ag^{105}	1	P^{32}	10
Ag^{111}	10	$Pd^{103} + Rh^{103}$	50
As^{76}, As^{77}	10	Pd^{109}	10
Au^{198}	10	Pm^{147}	10
Au^{199}	10	Po^{210}	0.1
$Ba^{140} + La^{140}$	1	Pr^{143}	10
Be^{7}	50	Pu^{239}	1
C^{14}	50	Ra^{226}	0.1
Ca^{45}	10	Rb^{86}	10
$Cd^{109} + Ag^{109}$	10	Re^{186}	10
$Ce^{144} + Pr^{144}$	1	Rh^{105}	10
Cl^{36}	1	$Ru^{106} + Rh^{106}$	1
Co^{60}	1	S^{35}	50
Cr^{51}	50	Sb^{124}	1
$Cs^{137} + Ba^{137}$	1	Sc^{46}	1
Cu^{64}	50	Sm^{153}	10
Eu^{154}	1	Sn^{113}	10
F^{18}	50	Sr^{89}	1
Fe^{55}	50	$Sr^{90} + Y^{90}$	0.1
Fe^{59}	1	Ta^{182}	10
Ga^{72}	10	Tc^{96}	1
Ge^{71}	50	Tc^{99}	1
H^3 (HTO or $H^3{}_2O$)	250	Te^{127}	10
I^{131}	10	Te^{129}	1
In^{114}	1	Th (natural)	50
Ir^{192}	10	Tl^{204}	50
K^{42}	10	Tritium. See H^3	250
La^{140}	10	U (natural)	50
Mn^{52}	1	U^{233}	1
Mn^{56}	50	U^{234}-U^{235}	50
Mo^{99}	10	V^{48}	1
Na^{22}	10	W^{185}	10
Na^{24}	10	Y^{90}	1
Nb^{95}	10	Y^{91}	1
Ni^{59}	1	Zn^{65}	10
Ni^{63}	1	Unidentified radioactive materials or any of the above in unknown mixtures	0.1

NOTE: For purposes of C. 11 and C. 18 where there is involved a combination of isotopes in known amounts the limit for the combination should be derived as follows: Determine, for each isotope in the combination, the ratio between the quantity present in the combination and the limit otherwise established for the specific isotope when not in combination. The sum of such ratios for all the isotopes in the combination may not exceed "1" (i.e., "unity").

EXAMPLE: For the purposes of C. 18 if a particular batch contains 2,000 uc of Au ^{198} and 25,000 us of C^{14}, it may also include not more than 3,000 uc of I^{131}. This limit was determined as follows:

$$\frac{2{,}000 \text{ uc } Au^{198}}{10{,}000 \text{ uc}} + \frac{25{,}000 \text{ uc } C^{14}}{50{,}000 \text{ uc}} + \frac{3{,}000 \text{ uc } I^{131}}{10{,}000 \text{ uc}} = 1$$

The denominator in each of the above ratios was obtained by multiplying the figure in the table by 1,000 as provided in C. 18.

Form MRH-30

MONTANA STATE DEPARTMENT OF HEALTH
OCCUPATIONAL EXTERNAL RADIATION EXPOSURE HISTORY

IDENTIFICATION

1. Name (Print—Last, First, and Middle) .... 2. Social Security No. ....

3. Date of Birth (Month, Day, Year) .... 4. Age in Full Years (N) ....

OCCUPATIONAL EXPOSURE — PREVIOUS HISTORY

5. Previous Employments Involving Radiation (List name and address of employers)	6. Dates of Employment (From - To)	7. Periods of Exposure	**PREVIOUS DOSE HISTORY** 8. Whole Body (rem)	9. Record or Calculated (Insert one)

10. Remarks

11. Accumulated Occupational Dose Total ....

13. Calculations—Permissible Dose

Whole Body:

a. Permissible accumulated dose— 5(N-18) .... rem.

b. Total exposure to date (From Item 11) .... rem.

c. Permissible dose .... rem.

12. Certification: I certify that the exposure history listed in columns 5, 6, and 7 is correct and complete to the best of my knowledge and belief.

....

(Employee's Signature) (Date)

14. ....

Name of licensee or registrant.

INSTRUCTIONS FOR PREPARATION OF DEPARTMENT OF HEALTH FORM MRH-30

This form or a clear and legible record containing all the information required on this form must be prepared by each licensee or registrant of the Montana State Department of Health who, pursuant to Section C.2, proposes to expose an individual to a radiation dose in excess of the amounts specified in Section C.2(a) of the regulations in Part C, "Standards for Protection Against Radiation." The requirement for completion of this form is contained in Section C.3 of that regulation. The information contained in this form is used for estimating the external accumulated occupational dose of the individual for whom the form is completed. A separate Department of Health Form "MRH-30" shall be completed for each individual to be exposed to a radiation dose in excess of the limits specified in Section C.2(a) of Part C of the Montana State Department of Health regulations.*

---

*This form requires the signature of the employee concerned.

Listed below by item are instructions and additional information directly pertinent to completing this form:

IDENTIFICATION

Item 1. Self-explanatory.

Item 2. Self-explanatory except that, if individual has no social security number, the word "none" shall be inserted.

Item 3. Self-explanatory.

Item 4. Enter the age in full years. This is called "N" when used in calculating the Permissible Dose. N is equal to the number of years of age of the individual on his last birthday.

OCCUPATIONAL EXPOSURE

Item 5. List the name and address of each previous employer and the address of employment. Start with the most recent employer and work back. Include only those periods of employment since the eighteenth birthday involving occupational exposure to radiation. For periods of self-employment, insert the word "self-employed."

Item 6. Give the dates of employment.

Item 7. List periods during which occupational exposure to radiation occurred.

Item 8. List the dose recorded for each period of exposure from records of previous occupational exposure of the individual as calculated under Section C.3. Dose is to be given in rem.

"Dose to the whole body" shall be deemed to include any dose to the whole body, gonads, active blood-forming organs, head and trunk, or lens of eye.

Item 9. After each entry in Item 8, indicate in Item 9 whether dose is obtained from records or calculated in accordance with Section C.3.

Item 10. Self-explanatory.

TOTAL ACCUMULATED OCCUPATIONAL DOSE (Whole Body)

Item 11. The total for the whole body is obtained by summation of all values in Item 8.

CERTIFICATION

Item 12. Upon completion of the report, the employee must certify that the information in Columns 5, 6, and 7 is accurate and complete to the best of his knowledge. The date is the date of his signature.

CALCULATIONS

Item 13. The lifetime accumulated occupational dose for each individual and the permissible dose under Section C.2(b) are obtained by carrying out the following steps: The value for N should be taken from Item 4, subtract 18 from N and multiply the difference by 5 rem. (For example, John Smith, age 32; N=32, PAD=5(32-18)=70 rem.) Enter total exposure to date from Item 11. Subtract (b) from (a) and enter the difference under (c). The value in (c) represents the unused part of the permissible accumulated dose. This value for permissible dose is to be carried forward to the Deptartment of Health Form MRH-31, "Current Occupational, External Radiation Exposure (Whole Body)."

Item 14. Self-explanatory.

Form MRH-31

MONTANA STATE DEPARTMENT OF HEALTH
CURRENT OCCUPATIONAL EXTERNAL RADIATION EXPOSURE

IDENTIFICATION

1. Name (Print — Last, First, Middle)	2. Social Security No.
3. Date of Birth (Month, Day, Year)	4. Name of licensee or registrant

OCCUPATIONAL EXPOSURE

5. DOSE RECORDED FOR (Specify: Whole body; skin of whole body; or hands and forearms; feet and ankles)	6. WHOLE BODY DOSE STATUS (rem)	7. METHOD OF MONITORING (e.g., film badge—FB; pocket chamber—PC; calculations—Calc) X or Gamma........ Beta........ Neutrons........

8. Period of Exposure (From-To)	Dose for the Period (rem)				13. Running total for calendar quarter (rem)
	9. X or Gamma	10. Beta	11. Neutron	12. Total	

LIFETIME ACCUMULATED DOSE

14. Previous Total (rem)	15. Total Quarterly Dose		16. Total Accumulated Dose (rem)	17. Perm. Acc. Dose 5 (N-18) (rem)	18. Unused Part of permissible accumulated dose (rem)
	Date	rem			

INSTRUCTIONS FOR PREPARATION OF DEPARTMENT OF HEALTH FORM MRH-31

The preparation and safekeeping of this form or a clear and legible record containing all the information required on this form is required pursuant to Section C.20 of "Standards for Protection Against Radiation," as a current record of occupational external radiation exposures. Such a record must be maintained for each individual for whom personnel monitoring is required under Section C.10. Note that a separate Department of Health Form MRH-31 is to be used for recording external exposure to (1) the whole body; (2) skin of whole body; (3) hands and forearms; or (4) feet and ankles, as provided by Item 5 below.

Listed below by item are instructions and additional information directly pertinent to completing this form.

IDENTIFICATION

Item 1. Self-explanatory.

Item 2. Self-explanatory except that, if individual has no social security number, the word "none" shall be inserted.

Item 3. Self-explanatory.

Item 4. Self-explanatory.

OCCUPATIONAL EXPOSURE

Item 5. "Dose to the whole body" shall be deemed to include any dose to the whole body, gonads, active blood-forming organs, head and trunk, or lens of eye. Unless the lenses of the eyes are protected with eye shields, dose recorded as whole body should include the dose delivered through a tissue equivalent absorber having a thickness of 300mg/cm^2 or less. When the lenses of the eyes are protected with eye shields having a tissue equivalent thickness of at least 700 mg/cm^2, dose recorded as whole body dose should include the dose delivered through a tissue equivalent absorber having a thickness of 1,000 mg/cm^2 or less. Dose recorded as dose to the skin of the whole body, hands and forearms, or feet and ankles should include the dose delivered through a tissue equivalent absorber having a thickness of 7 mg/cm^2 or less. The dose to the skin of the whole body, hands and forearms, or feet and ankles should be recorded on separate forms unless the dose to those parts of the body has been included as dose to the whole body on a form maintained for recording whole body exposure.

Item 6. This item need be completed only when the sheet is used to record whole body exposures and the licensee or registrant is exposing the individual under the provisions of Section C.2(b) which allows up to 3 rems per quarter to the whole body. Enter in this item the unused part of permissible accumulated dose taken from previous records of exposure, i.e., Item 18 of the preceding Department of Health Form MRH-31 or Item 13 of Department of Health Form MRH-30 if the individual's exposure during employment with the licensee or registrant begins with this record.

Item 7. Indicate the method used for monitoring the individual's exposure to each type of radiation to which he is exposed in the course of his duties. Abbreviations may be used.

Item 8. Doses received over a period of less than a calendar quarter need not be separately entered on the form provided that the licensee or registrant maintains a current record of the doses received by the individual which have not as yet been entered on the form. The period of exposure should specify the day the measurement of that exposure was initiated and the day on which it was terminated. For example, if only quarterly doses are entered, the period of exposure for the first calendar quarter of 1969 might be taken as running from Monday, January 1, 1969, through Friday, March 30, 1969, and would be indicated in this item as Jan. 1, 1969 - Mar. 30, 1969. If weekly doses are entered, a film badge issued Monday morning, January 1, 1969, and picked up Friday, January 5, 1969, would be indicated as Jan. 1, 1969 - Jan. 5, 1969.

Items 9, 10, & 11. Self-explanatory. The values are to be given in rem. All measurements are to be interpreted in the best method known and in accordance with Section A.5(c). Where calculations are made to determine dose, a copy of such calculations is to be maintained in conjunction with this record. In any case where the dose for a calendar quarter is less than 10% of the value specified in Section C.2(a), the phrase "less than 10%" may be entered in lieu of a numerical value.

Item 12. Add the values under Items 9, 10, and 11 for each period of exposure and record the total. In calculating the "Total" any entry "less than 10%" may be disregarded.

Item 13. The running total is to be maintained on the basis of calendar quarters. Section A.2(a) (6) defines calendar quarter. No entry need be made in this item if only calendar quarter radiation doses are recorded in Items 9 ,10, 11, and 12.

LIFETIME ACCUMULATED DOSE (Whole Body)

NOTE: If the licensee or registrant chooses to keep the individual's exposure below that permitted in Section C.2(a), Items 14 through 18 need not be completed. However, in that case the total whole body dose for each calendar quarter recorded in Item 13 (or in Item 12 if quarterly doses are entered in Item 12) should not exceed 1¼ rem.

If an individual is exposed under the provisions of Section C.2(b), complete Items 14 through 18 at the end of each calendar quarter, and when the sheet is filled. Values in Item 13, when in the middle of a calendar quarter, and values in Item 18, must be brought forward to next sheet for each individual.

Item 14. Enter the previous total accumulated dose from previous dose records for the individual (e.g., from Item 16 of Department of Health Form MRH-31 or Item 11 of Department of Health Form MRH-30). The total occupational radiation dose received by the individual must be entered in this item, including any occupational dose received from sources of radiation not licensed or registered by the Department. If the individual was exposed to sources of radiation not licensed or registered by the Department during any calendar quarter after completing Department of Health Form MRH-30 and personnel monitoring equipment was not worn by the individual, it should be assumed that the individual received a dose of 1¼ rems during each such calendar quarter.

Item 15. Enter the total calendar quarter dose from Item 13 (or from Item 12 if quarterly doses are entered in Item 12) and the date designating the end of the calendar quarter in which the dose was received (e.g., March 30, 1969).

Item 16. Add Item 14 and Item 15 and enter that sum.

Item 17. Obtain the Permissible Accumulated Dose (PAD) in rem for the WHOLE BODY. "N" is equal to the number of years of age of the individual on his last birthday. Subtract 18 from N and multiply the difference by 5 rem (e.g., John Smith, age 32; N=32; PAD=5 (32-18)=70 rem.)

Item 18. Determine the unused part of the PAD by subtracting Item 16 from Item 17. The unused part of the PAD is that portion of the Lifetime Accumulated Dose for the individual remaining at the end of the period covered by this sheet.

Part D

RADIATION SAFETY REQUIREMENTS FOR INDUSTRIAL RADIOGRAPHIC OPERATIONS

Sec. D. 1 Purpose: The regulations in this part establish radiation safety requirements for persons utilizing sources of radiation for industrial radiography. The requirements of this Part are in addition to and not in substitution for the other requirements of these regulations.

Sec. D. 2 Scope: The regulations in this part apply to all licensees or registrants who use sources of radiation for industrial radiography; provided, however, that nothing in this part shall apply to uses of sources of radiation in the healing arts.

Sec. D. 3 Definitions as Used in This Part:

(a) "Cabinet radiography-using radiation machines" means industrial radiography-using radiation machines, which are conducted in an enclosed, interlocked cabinet, such that the radiation machine will not operate unless all openings are securely closed, and which cabinet is so shielded that every location on the exterior meets conditions for an uncontrolled area as specified in Section C.6.

(b) "Industrial radiography" means the examination of the macroscopic structure of materials by nondestructive methods utilizing sources of radiation.

(c) "Radiographer" means any individual who performs or who, while in attendance at the site where sources of radiation are being used, personally supervises industrial radiographic operations and who is responsible to the licensee or registrant for assuring compliance with the requirements of these regulations and all license conditions.

(d) "Radiographer's Assistant" means any individual who, under the personal supervision of a radiographer, uses sources of radiation, related handling tools, or survey instruments in industrial radiography.

(e) "Radiographic exposure device" means any instrument containing a sealed source fastened or contained therein, in which the sealed source or shielding thereof may be moved, or otherwise changed, from a shielded to unshielded position for purpose of making a radiographic exposure.

(f) "Shielded room radiography-using radiation machines" means industrial radiography-using radiation machines which is conducted in an enclosed room, the interior of which is not occupied during radiographic operation, which is so shielded that every location on the exterior meets conditions for an uncontrolled area as specified in Section C.6, and the only access to which is through openings which are interlocked so that the radiation machine will not operate unless all openings are securely closed.

(g) "Storage container" means a device in which sealed sources are transported or stored.

EQUIPMENT CONTROL

Sec. D. 4 Limits on Levels of Radiation for Radiographic Exposure Devices and Storage Containers. Radiographic exposure devices measuring less than four (4) inches from the sealed source storage position to any exterior surface of the device shall have no radiation level in excess of 50 milliroentgens per hour at six (6) inches from any exterior surface of the device. Radiographic exposure devices measuring a minimum of four (4) inches from the sealed source storage position to any exterior surface of the device, and all storage containers for radiographic exposure devices, shall have no radiation level in excess of 200 milliroentgens per hour at any exterior surface, and ten (10) milliroentgens per hour at one meter from any exterior surface, the radiation levels specified are with the sealed source in the shielded (i.e., "off") position.

Sec. D. 5 Locking of Sources of Radiation. Each source of radiation shall be provided with a lock or outer-locked container designed to prevent unauthorized or accidental production of radiation or removal or exposure of a sealed source and shall be kept locked at all times except when under the direct surveillance of a radiographer or radiographer's assistant, or as may be otherwise authorized pursuant to Section D.30. Each storage container likewise shall be provided with a lock and kept locked when containing sealed sources except when the container is under the direct surveillance of a radiographer or radiographer's assistant.

Sec. D. 6 Storage Precautions. Locked radiographic exposure devices and storage containers shall be physically secured to prevent tampering or removal by unauthorized personnel.

Sec. D. 7 Radiation Survey Instruments. The licensee or registrant shall maintain sufficient calibrated and operable radiation survey instruments to make physical radiation surveys as required by this Part and Part C. of these regulations. Each radiation survey instrument shall be calibrated at intervals not to exceed three (3) months and after each instrument servicing and a record maintained of the latest date of calibration. Instrumentation required by this section shall have a range such that two (2) milliroentgens per hour through one roentgen per hour can be measured.

Sec. D. 8 Leak Testing, Repair, Tagging, Opening Modification, and Replacement of Sealed Sources.

(a) The replacement of any sealed source fastened to or contained in a radiographic exposure device and leak testing, repair, opening, or any other modification of any sealed source shall be performed only by persons specifically authorized to do so by the Department, the U. S. Atomic Energy Commission, or any agreement state.

(b) Each sealed source shall be tested for leakage at intervals not to exceed 6 months. In the absence of a certificate from a transferor that a test has been made within the 6 month period prior to the transfer, the sealed source shall not be put into use until tested.

(c) The leak test shall be capable of detecting the presence of 0.005 microcurie of removable contamination on the sealed source. An acceptable leak test for sealed sources in the possession of a radiography licensee is to test at the nearest accessible point to the sealed source storage position, or other appropriate measuring point, by a procedure to be approved pursuant to Section B.26(f). Records of leak test results shall be kept in units of microcuries and maintained for inspection by the Department.

(d) Any test conducted pursuant to paragraphs (b) and (c) of this section which reveals the presence of 0.005 microcurie or more of removable radioactive material shall be considered evidence that the sealed source is leaking. The licensee shall immediately withdraw the equipment involved from use and shall cause it to be decontaminated and repaired or to be disposed of, in accordance with regulations of the Department. Within 5 days after obtaining results of the test, the licensee shall file a report with the Department describing the equipment involved, the test results, and the corrective action taken.

(e) A sealed source which is not fastened to or contained in a radiographic exposure device shall have permanently attached to it a durable tag at least one (1) inch square bearing the prescribed radiation caution symbol in conventional colors, magenta or purple on a yellow background, and at least the instructions: "Danger—Radioactive Material—Do Not Handle—Notify Civil Authorities if Found."

Sec. D. 9 Quarterly Inventory. Each licensee or registrant shall conduct a quarterly physical inventory to account for all sources of radiation received or possessed by him. The records of the inventories shall be maintained for inspection by the Department and shall include the quantities and kinds of radioactive material, the location of all sources of radiation, and the date of the inventory.

Sec. D. 10 Utilization Logs. Each licensee or registrant shall maintain current logs, which shall be kept available for inspection by the Department, showing for each source of radiation the following information:

(a) A description (or make and model number) of each source of radiation or storage container in which the sealed source is located;

(b) The identity of the radiographer to whom assigned;

(c) Locations where used and dates of use; and,

(d) The voltage, current, and exposure time for each radiographic exposure employing a radiation machine.

PERSONAL RADIATION SAFETY REQUIREMENTS FOR RADIOGRAPHERS AND RADIOGRAPHER'S ASSISTANTS

Sec. D. 20 Limitations:

(a) No licensee or registrant shall permit any person to act as a radiographer as defined in this Part until such person:

(1) Has been instructed in the subjects outlined in Appendix A of this Part and shall have demonstrated understanding thereof;

(2) Has received copies of and instruction in the regulations contained in this Part and the applicable sections of Part C, Department License(s), and the licensee's or registrant's operating and emergency procedures, and shall have demonstrated understanding thereof; and

(3) Has demonstrated competence to use the source of radiation, related handling tools, and survey instruments which will be employed in his assignment.

(b) No licensee or registrant shall permit any person to act as a radiographer's assistant as defined in this Part until such person:

(1) Has received copies of and instructions in the licensee's or registrant's operating and emergency procedures, and shall have demonstrated understanding thereof; and,

(2) Has demonstrated competence to use under the personal supervision of the radiographer the sources of radiation and survey instruments which will be employed in his assignment.

Sec. D. 21 Operating and Emergency Procedures. The licensee's or registrant's operating and emergency procedures shall include instructions in at least the following:

(a) The handling and use of sources of radiation to be employed such that no person is likely to be exposed to radiation doses in excess of the limits established in Part C, "Standards for Protection Against Radiation";

(b) Methods and occasions for conducting radiation surveys;

(c) Methods for controlling access to radiographic areas;

(d) Methods and occasions for locking and securing sources of radiation;

(e) Personnel monitoring and the use of personnel monitoring equipment;

(f) Transportation to field locations, including packing of sources of radiation in the vehicles, posting of the vehicles, and control of sources of radiation during transportation;

(g) Minimizing exposure of persons in the event of an accident;

(h) The procedure for notifying proper persons in the event of an accident; and,

(i) Maintenance of records.

Sec. D. 22 Personnel Monitoring Control.

(a) No licensee or registrant shall permit any person to act as a radiographer or as a radiographer's assistant unless, at all times during radiographic operations, each person shall wear a film badge and either a pocket dosimeter or pocket chamber. Pocket dosimeters and pocket chambers shall be capable of measuring doses from zero to at least 200 milliroentgens. A film badge shall be assigned to and worn by only one person.

(b) Pocket dosimeters and pocket chambers shall be read and doses recorded daily. A film badge shall be immediately processed if a pocket chamber or pocket dosimeter is discharged beyond its range. The film badge reports received from the film badge processor and records of pocket dosimeter and pocket chamber readings shall be maintained for inspection by the Department.

Sec. D. 30 Security. During each radiographic operation, the radiographer's assistant shall maintain a direct surveillance of the operation to protect against unauthorized entry into a high radiation area, as defined in Part C, except (a) where the high radiation area is equipped with a control device or an alarm system as described in Section C.11(c)(2) or (b) where the high radiation area is locked to protect against unauthorized or accidental entry.

Sec. D. 31 Posting. Notwithstanding any provisions in Section C.12(c) areas in which radiography is being performed shall be conspicuously posted as required by Section C.11(b) and (c)(1).

Sec. D. 32 Radiation Surveys and Survey Records.

(a) No radiographic operation shall be conducted unless calibrated and operable radiation survey instrumentation as described in Section D.7 is available and used at each site where radiographic exposures are made.

(b) A physical radiation survey shall be made after each radiographic exposure utilizing radiographic exposure devices or sealed sources of radioactive material to determine that the sealed source has been returned to its shielded condition.

(c) A physical radiation survey shall be made to determine that each sealed source is in its shielded condition prior to securing the radiographic exposure device or storage container as specified in Section D.5.

(d) Records shall be kept of the surveys required by paragraph (c) of this section and maintained for inspection by the Department.

Sec. D. 33 Special Requirements for Radiography-Employing Radiation Machines.

(a) **Cabinet Radiography.** Cabinet radiography-using radiation machines shall be exempt from other requirements of this Part D; however, no registrant shall permit any individual to operate a cabinet radiography unit until such individual has received a copy of, and instruction in, and demonstrated an understanding of operating procedures for the unit, and has demonstrated competence in its use.

(b) **Shielded Room Radiography.** Shielded room radiography-using radiation machines shall be exempt from other requirements of this Part D; however,

(1) No registrant shall permit any individual to operate a radiation machine for shielded room radiography until such individual has received a copy of, and instruction in, and demonstrated an understanding of operating procedures for that unit, and has demonstrated competence in its use.

(2) Each registrant shall supply appropriate personnel monitoring equipment to, and shall require the use of such equipment by, every individual who operates, who makes "set-ups", or who performs maintenance on a radiation machine for shielded room radiography.

(3) A physical radiation survey shall be conducted to determine that the radiation machine is "off" prior to each entry into the shielded room. Such surveys shall be made with a radiation measuring instrument capable of measuring radiation of the energies and at the dose rates to be encountered, which is in good working order, and which has been properly calibrated within the preceding three months or following the last instrument servicing, whichever is later.

(c) Other radiography using radiation machines shall be exempt from Sections D.4, D.6, D.8, and D.32 of this Part; however,

(1) A physical radiation survey shall be conducted to determine that the radiation machine is "off" prior to each entry into the radiographic exposure area. Such surveys shall be made with a radiation measuring instrument capable of measuring radiation of the energies and at the dose rates to be encountered, which is in good working order, and which has been properly calibrated within the preceding three months or following the last instrument servicing, whichever is later. Survey results and records of boundary locations shall be maintained and kept available for inspection.

(2) Mobile or portable radiation machines shall be physically secured to prevent removal by unauthorized personnel.

Appendix A

INSTRUCTION OF RADIOGRAPHERS

I. Fundamentals of Radiation Safety

A. Characteristics of gamma and X-radiation.

B. Units of radiation dose (mrem) and quantity of radioactivity (curie).

C. Hazards of excessive exposure of radiation.

D. Levels of radiation from sources of radiation.

- E. Methods of controlling radiation dose
  - 1. Working time
  - 2. Working Distances
  - 3. Shielding

II. Radiation Detection Instrumentation to be Used

- A. Use of radiation survey instruments
  - 1. Operation
  - 2. Calibration
  - 3. Limitations
- B. Survey techniques
- C. Use of personnel monitoring equipment
  - 1. Film badges
  - 2. Pocket dosimeters
  - 3. Pocket chambers

III. Radiographic Equipment to be Used

- A. Remote handling equipment
- B. Radiographic exposure devices and sealed sources
- C. Storage containers
- D. Operation and control of X-ray equipment

IV. The Requirements of Pertinent Federal and State Regulations

V. The Licensee's or Registrant's Written Operating and Emergency Procedures.

Part E

USE OF X-RAYS IN THE HEALING ARTS

Sec. E. 1 Scope. This Part establishes requirements for use of X-ray producing devices in the healing arts by a practitioner licensed by law to use or direct the use of such devices in the course of his professional practice or upon a prescription or other order lawfully issued in the course of his professional practice. The provisions of this Part are in addition to, and not in substitution for, other applicable provisions of these regulations.

Sec. E. 2 Definitions

(a) **"Aluminum equivalent"** means the thickness of aluminum affording the same attenuation, under specified conditions, as the material in question.

(b) **"Dead-man switch"** means a switch so constructed that a circuit-closing contact can only be maintained by continuous pressure by the operator.

(c) **"Diagnostic-type tube housing"** means an X-ray tube housing so constructed that leakage radiation at a distance of one (1) meter from the target cannot exceed one hundred (100) milliroentgens in one (1) hour when the tube is operated at any of its specified ratings.

(d) **"Filter"** means material placed in the useful beam to absorb preferentially the less penetrating radiations.

(e) **"Half-value layer (hvl)"** means the thickness of an absorber required to reduce a beam of radiation to one-half its incident exposure rate.

(f) **"Inherent filtration"** means the filtration in the useful beam due to the window of the X-ray tube and any permanent tube enclosure.

(g) **"Interlock"** means a device for precluding access to an area of radiation hazard either by preventing entry or by automatically removing the hazard.

(h) **"Kilovolts peak (kvp)"** means the crest value in kilovolts of the potential of a pulsating potential generator. When only one-half of the wave is used, the value refers to the useful half of the wave.

(i) **"Lead equivalent"** means the thickness of lead affording the same attenuation, under specified conditions, as the material in question.

(j) **"Leakage radiation"** means all radiation coming from within the tube housing except the useful beam.

(k) **"Primary protective barrier"** means a barrier sufficient to attenuate the useful beam to the required degree.

(l) **"Protective apron"** means an apron made of attenuating materials, used to reduce radiation exposure.

(m) **"Protective barrier"** means a barrier of attenuating materials used to reduce radiation exposure.

(n) **"Protective glove"** means a glove made of attenuating materials used to reduce radiation exposure.

(o) **"Scattered radiation"** means radiation that, during passage through matter, has been deviated in direction.

(p) **"Secondary protective barrier"** means a barrier sufficient to attenuate stray radiation to the required degree.

(q) **"Shutter"** means a device, generally of lead, fixed to an X-ray tube housing to intercept the useful beam.

(r) **"Stray radiation"** means radiation not serving any useful purpose. It includes leakage and secondary radiation.

(s) **"Therapeutic-type tube housing"** means an X-ray tube housing so constructed that the leakage radiation at a distance of one (1) meter from the target cannot exceed one (1) roentgen in one (1) hour; and at a distance of five (5) centimeters from any point on the surface of the housing accessible to the patient cannot exceed thirty (30) roentgens in one (1) hour when the tube is operated at any of its specified ratings.

(t) **"Useful beam"** means that part of the radiation which passes through the window, aperature, cone, or other collimating device of the tube housing.

Sec. E. 3 General Safety Provisions

(a) The Department may waive compliance with the specific requirements of this Part by an existing machine or installation if the registrant demonstrates, to the Department's satisfaction, achievement through other means of radiation protection equivalent to that required by these regulations.

(b) No person shall make, sell, lease, transfer, lend or install X-ray equipment or the supplies used in connection with such equipment unless such supplies and equipment, when properly placed in operation and properly used, will meet the requirements of these regulations. This includes responsibility for the delivery of cones or collimators, diaphragms and adjustable diaphragms, filters, adequate timers, and fluoroscopic shutters (where applicable).

(c) Personnel monitoring shall be performed in controlled areas for each occupationally exposed individual for a minimum of a thirteen-week period starting each January.

(d) Use

(1) The registrant shall be responsible for radiation safety. He is responsible for assuring that radiation sources under his jurisdiction are used only by persons competent to use them. He is responsible for providing the instruction of personnel in safe operating procedures.

(2) A radiation safety officer (who may be the registrant himself) shall be designated for every installation and shall be approved by the Department as per Section B.60(a) (2), if other than a licensed member of the healing arts.

(3) The specific responsibilities of the radiation safety officer are:

(i) To establish and supervise operating procedures and to review them periodically to assure their conformity with these rules and regulations.

(ii) To provide personnel with instruction on proper radiation protection practices.

(iii) To have conducted radiation surveys and source leak tests where indicated and to keep records of such surveys and tests, including summaries of corrective measures recommended and/or instituted.

(iv) To assure that personal monitoring devices are used where indicated and that records are kept of the results of such monitoring.

(v) To assure that interlock switches and warning signals are functioning and that signs are properly located.

(vi) To investigate each known or suspected case of excessive or abnormal exposure to determine the cause and to take steps to prevent its recurrence.

(4) The registrant shall make available to each individual operating X-ray equipment under his control a copy of Montana State Regulations or appropriate portions extracted from the Montana State Regulations and other authoritative literature as required by the Department.

(5) Deliberate exposure of an individual to the useful beam for training or demonstration purposes shall not be permitted unless there is also a medical (or dental) indication for the exposure and the exposure is prescribed by a practitioner of the healing arts.

(e) **Shielding.**

(1) Each installation shall be provided with such primary protective barriers and/or secondary protective barriers as are necessary to assure compliance with Sections C2, C5, and C6. This requirement shall be deemed to be met if the thickness of such barriers are equivalent to those as computed in accordance with Appendix C, National Bureau of Standards Handbook 76: "Medical X-ray Protection Up to Three Million Volts."

(2) Lead barriers shall be mounted in such a manner that they will not sag or cold-flow because of their own weight and shall be protected against mechanical damage. Lead shielding less than 1-mm thick shall be bonded to panels of some rigid supporting material.

(3) Joints between different kinds of protective materials shall be so designed that the overall protection afforded by the barrier is not impaired.

(4) Joints at the floor and ceiling shall be so designed that the overall protection is not impaired.

(5) Windows, window frames, doors, and door frames shall have the same lead equivalent as that required of the adjacent wall.

(6) Holes in protective barriers shall be covered so that overall protection is not impaired.

Sec. E. 4 Prohibited Use.

(a) No registrant shall operate or permit the operation of X-ray equipment unless the equipment and installation meet the applicable requirements of these regulations.

Sec. E. 5 Fluoroscopic Installations.

(a) Equipment

(1) The tube housing shall be of a diagnostic type.

(2) The source-panel or source-table distance of equipment installed before July 1, 1969, shall not be less than twelve (12)

inches, and shall not be less than fifteen (15) inches in equipment installed or re-installed thereafter. The source-skin distance of image intensifier equipment shall not be less than 15 inches.

(3) The total filtration permanently in the useful beam shall be at least 2.5 millimeters aluminum equivalent.

(4) The equipment shall be so constructed that, under conditions of normal use, the entire cross section of the useful beam is attenuated by a primary protective barrier, permanently incorporated into the equipment and the exposure shall automatically terminate when the barrier is removed from the useful beam.

(i) The lead equivalent of the barrier of conventional fluoroscopes shall be at least 1.5 millimeters for equipment capable of operating up to 100 kvp, at least 1.8 millimeters for equipment capable of operating between 100 kvp and 125 kvp, and at least 2.0 millimeters for equipment capable of operating between 125 kvp and 150 kvp.

(ii) With the fluorescent screen 14 in. (35 cm) from the panel or table top, the exposure rate 2 in (5cm) beyond the viewing surface of the screen shall not exceed 30 MR/h for each R per minute at the table top with the screen in the useful beam without a patient and with the fluoroscope operating at its highest possible potential.

(iii) A collimator shall be provided to restrict the size of the useful beam to less than the area of the barrier. The X-ray tube and collimating system shall be linked with the fluorescent screen assembly so that the useful beam at the fluorescent screen is confined within the barrier irrespective of the panel-screen distance. For all new fluoroscopic units with image intensifiers, sold in Montana after July 1, 1969, the useful beam shall be centered on the input phosphor and during fluoroscopy or cine recording shall not exceed the diameter of the input phosphor.

(iv) When the adjustable diaphragm is opened to its fullest extent, an unilluminated margin shall exist at all edges of the fluorescent screen when the screen is 14 in. (35 cm) from the panel surface or table top or at the fixed screen position in equipment such as orthodiascopes. In equipment used solely for image intensified fluoroscopy, the shutter shall restrict the useful beam within the diameter of the input phosphor.

(v) Collimators, adjustable diaphragms and shutters shall provide the same degree of attenuation as is required of the tube housing.

(5) The fluoroscopic exposure switch shall be of the dead-man type.

(6) A shielding device of at least 0.25 millimeters lead equivalent for covering the Bucky slot during fluoroscopy shall be provided on all new units sold in Montana after July 1, 1969.

(7) A shield of at least 0.25 millimeters lead equivalent such as overlapping protective drapes or hinged or sliding panels shall be provided on all new units sold in Montana after July 1, 1969, to intercept scattered radiation which would otherwise reach the fluoroscopist and others near the machine.

(8) A cumulative timing device activated by the fluoroscope exposure switch shall be provided. It shall indicate the passage of a predetermined period of irradiation either by an audible signal or by temporary interruption of the irradiation when the increment of exposure time reaches a predetermined limit not exceeding five minutes.

(9) Image intensification shall always be provided on mobile fluoroscopic equipment. It shall be impossible to operate mobile fluoroscopic equipment unless the useful beam is intercepted by the image intensifier. Mobile fluoroscopes shall be provided with cone spacer frames of sufficient length to limit the source-skin distance to not less than 12 inches (30 cm).

(10) Provision shall be made to intercept the scattered X-rays from the undersurface of the table top and other structures under the table. The shielding shall provide the same degree of attenuation as is required of the tube housing, with the incident angle of the useful beam taken into consideration.

(11) Equipment to be operated in areas where explosive gases may be used shall have the approval of Underwriters Laboratory for such use.

(b) **Structural Shielding.**

(1) Ordinarily, only secondary protective barriers are necessary except for combined fluoroscopic-radiagraphic installations.

(c) **Operating Procedures.**

(1) The exposure rate used in fluoroscopy shall be as low as is consistent with the fluoroscopic requirements and shall not exceed 5 R/Min (measured in air) at the position where the beam enters the patient.

(2) The fluoroscopist's eyes shall be sufficiently dark adapted (20 minutes) for the visual task required before commencing fluoroscopy.

(3) Extraneous light that interferes with the fluoroscopic examination shall be eliminated.

(4) Protective aprons of at least 0.25 millimeters lead equivalent shall be worn in the fluoroscopy room by each person except the patient.

(5) Only persons whose presence is necessary shall be in the fluoroscopy room during X-ray exposures.

(6) Fluoroscopy shall not be used as a substitute for radiography but shall be reserved for the study of dynamics or spatial relationships or for guidance in spot-film recording of critical details.

(7) Special precautions, consistent with clinical needs, shall be taken to minimize exposure of the gonads of potentially procreative patients and exposure of the embryo or fetus in patients known to be or suspected of being pregnant.

(8) Notwithstanding paragraph (a) of Section C.10, personnel monitoring is required for each individual who enters a controlled area.

Sec. E. 6 Dental Radiographic Installations.

(a) **Equipment**

(1) The tube housing shall be of diagnostic type.

(2) Diaphragms or cones shall be used for collimating the useful beam and provide the same degree of protection as the housing. The diameter of the useful beam at the cone tip shall not be more than three (3) inches for intra-oral radiography.

(3) A cone or spacer frame shall provide a target-to-skin distance of not less than seven (7) inches with apparatus operating above fifty (50) kvp or four (4) inches with apparatus operating at fifty (50) kvp or below.

(4) For equipment capable of operating up to no more than seventy (70) kvp, the total filtration permanently in the useful beam shall be equivalent to at least 1.5 mm of aluminum. This requirement may be assumed to have been met if the half-value layer is not less than 1.5 mm aluminum at maximum possible operating voltages.

(5) For equipment capable of operating above seventy (70) kvp, the total filtration permanently in the useful beam shall be equivalent to at least 2.5 mm of aluminum. This requirement may be assumed to have been met if the half-value layer is not less than 2.5 mm aluminum at the maximum possible operating voltage.

(6) A device shall be provided to terminate the exposure after a preset time or exposure.

(7) The exposure control switch shall be of the dead-man type.

(8) Each installation shall be provided with a protective barrier for the operator or shall be so arranged that the operator can stand at least six (6) feet from the useful beam.

(b) **Structural Shielding.**

(1) Dental rooms containing X-ray machines shall be provided with primary protective barriers at all areas struck by the useful beam. Consideration shall be given to the attenuation provided by the patient and building materials in partitions.

(2) When dental X-ray units are installed in adjacent rooms or areas, protective barriers shall be provided between the rooms or areas. Consideration of the effects of the separating wall(s) shall be given in the evaluation of this protection.

(c) **Operating Procedures.**

(1) Neither the dentist nor his assistant shall be permitted to hold patients or films during exposure, nor shall any individual be regularly used for this service.

(2) During each exposure, the operator shall stand at least six (6) feet from the patient or behind a protective barrier.

(3) Only the patient shall be in the useful beam.

(4) Neither the tube housing nor the pointer cone shall be hand-held during exposure.

(5) Fluoroscopy shall not be used in dental examinations.

(6) Personnel monitoring shall be performed in controlled areas for each occupationally exposed individual beyond the required thirteen-week period, for whom there is a reasonable possibility of receiving a dose exceeding one-fourth the applicable maximum permissible dose.

Sec. E. 7 Veterinary Medicine Radiographic Installations.

(a) **Equipment.**

(1) The tube housing shall be of diagnostic type.

(2) Diaphragms or cones shall be provided for collimating the useful beam to the area of clinical interest and shall provide the same degree of protection as is required of the housing.

(3) Except when contraindicated for a particular radiographic purpose, the total filtration permanently in the useful beam shall not be less than 1.5 millimeters aluminum-equivalent for equipment capable of operating up to no more than seventy (70) kvp and 2.5 millimeters aluminum-equivalent for machines capable of operating in excess of seventy (70) kvp.

(4) A device shall be provided to terminate the exposure after a pre-set time or exposure.

(5) A dead-man type of exposure switch shall be provided, together with an electrical cord of sufficient length so that the operator can stand out of the useful beam and at least six (6) feet from the animal during all X-ray exposures.

(b) **Structural Shielding.**

(1) All wall, ceiling, and floor areas shall be equivalent to or provided with applicable protective barriers as required in Section E.8(b).

(c) **Operating Procedures.**

(1) The operator shall stand at least six (6) feet from the tube housing and the animal during radiographic exposures. Provisions shall be made so that the operator will not be required to stand in the useful beam.

(2) Hand-held fluoroscopic screens shall not be used.

(3) The tube housing shall not be held by the operator.

(4) No individual other than the operator shall be in the X-ray

room while exposures are being made unless such individual's assistance is required.

(5) In any application in which the operator or other assisting individual is not located behind a protective barrier, clothing consisting of a protective apron having a lead-equivalent of not less than 0.5 millimeter shall be worn by the operator and any other individuals in the room during exposures.

(6) No individual shall be regularly employed to hold or support animals, or hold film during radiation exposures. Operating personnel shall not perform this service except in cases in which no other method is available. Any individual holding or supporting an animal during radiation exposure shall wear protective gloves and apron having a lead-equivalent of not less than 0.5 millimeter.

(7) Personnel monitoring shall be performed in controlled areas for each occupationally exposed individual beyond the required thirteen-week period, for whom there is a reasonable possibility of receiving a dose exceeding one-fourth the applicable maximum permissible dose.

Sec. E. 8 Radiographic Installations Other Than Dental and Veterinary Medicine.

(a) **Equipment.**

(1) The tube housing will be of diagnostic type.

(2) Suitable devices (diaphragms, cones, adjustable collimators), capable of restricting the useful beam to the area of clinical interest shall be provided to define the beam and shall provide the same degree of attenuation as that required of the tube housing. Such devices shall be calibrated in terms of the size of the projected useful beam at specified source-film distances. For chest photofluorographic equipment, the collimator shall restrict the beam to dimensions no greater than those of the fluorographic screen and shall confine the beam to the screen.

(3) Radiographic equipment, including multipurpose machines sold in Montana after July 1, 1969, shall be equipped with adjustable rectangular collimators containing light localizers that define the entire field. Equipment prior to these regulations utilizing circular collimators which have met or will meet established standards will be acceptable. The field size indication on adjustable collimators shall be accurate with a tolerance not exceeding one inch for a source-film distance

of 72 inches, the light field shall align with the X-ray field with the same degree of accuracy.

(4) The size of the X-ray beam projected by **fixed aperture** cones and collimators (except those used for stero-radiography) should not exceed the minimum dimensions of the X-ray film by more than 2 inches (1 inch border) for a source-film distance of 72 inches or 1 inch (½ inch border) for a source-film distance of 36 inches.

(5) Except when contraindicated for a particular radiographic purpose, the aluminum equivalent of the total filtration in the primary beam shall not be less than 0.5 millimeters aluminum for machines capable of operating not over 50 kvp, 1.5 millimeters for those capable of operating between 50-70 kvp and 2.5 millimeters for those capable of operating above 70 kvp.

(6) A device shall be provided which terminates the exposure at a pre-set time interval or exposure. The operator shall be able to terminate the exposure at any time.

(7) The dead-man type exposure switch, except for those used in conjunction with "spot-film", shall be so arranged that it cannot be operated outside a shielded area.

(8) The control panel shall include a device (such as a milliammeter or equivalent) to give positive indication of the production of X-rays whenever the X-ray tube is energized.

(9) The control panel shall include devices (labelled control settings and/or meters) indicating the physical factors (such as kvp, ma, exposure time or whether timing is automatic) used for the exposure.

(10) Machines equipped with beryllium window X-ray tubes shall contain keyed filter interlock switches in the tube housing and suitable indication on the control panel of the added filter in the useful beam if the total filtration permanently in the useful beam is less than 0.5 mm aluminum equivalent. The total filtration permanently in the useful beam shall be clearly indicated on the tube housing.

(11) Beryllium window X-ray tubes shall not be used on multi-purpose radiographic equipment.

(12) Gonadal shielding shall be used for the patient when appropriate.

(13) When a patient must be held in position for radiography, mechanical supporting or restraining devices shall be used

whenever possible. If the patient must be held by an individual, that individual shall be protected with appropriate shielding devices such as protective gloves and apron and he shall be so positioned that no part of his body will be struck by the useful beam and that his body is as far as possible from the edge of the useful beam.

(14) Only persons whose presence is necessary shall be in the radiographic room during exposure. All such persons shall be protected.

(b) **Structural Shielding.**

(1) All wall, floor, and ceiling areas exposed to the useful beam shall have primary barriers. Primary barriers in walls shall extend to a minimum height of eighty-four (84) inches above the floor.

(2) Secondary barriers shall be provided in all wall, floor, and ceiling areas not having primary barriers or where the primary barrier requirements are lower than the seconday barrier requirements.

(3) The operator's station at the control shall be behind a protective barrier, either in a separate room, in a protected booth, or behind a shield which will intercept the useful beam and any radiation which has been scattered only once.

(4) A window of lead-equivalent glass equal to that required by the adjacent barrier or a mirror system shall be provided large enough and so placed that the operator can see the patient without having to leave the protected area during exposure.

(c) **Operating Procedures.**

(1) Personnel monitoring shall be performed in controlled areas for each occupationally exposed individual beyond the required thirteen-week period, for whom there is a reasonable possibility of receiving a dose exceeding one-fourth the applicable maximum permissible dose.

(2) No individual occupationally exposed to radiation shall be permitted to hold patients during exposures except during emergencies, nor shall any individual be regularly used for this service.

(3) Only individuals required for the radiographic procedure shall be in the radiographic room during exposure; and,

except for the patient, no unprotected parts of their bodies shall be in the useful beam.

(4) The useful beam shall be restricted to the area of clinical interest.

Sec. E. 9 Special Requirements for Mobile Diagnostic Radiographic Equipment.

(a) **Equipment.**

(1) All requirements of Section E.8(a) apply except E.8(a) (7).

(2) A dead-man type of exposure switch shall be provided, together with electrical cord of sufficient length so that the operator can stand at least six (6) feet from the useful beam.

(b) **Structural Shielding.** When a mobile unit is used routinely in one location, it shall be considered a fixed installation subject to the shielding requirements specified in E.3(e) and E.8(b).

(c) **Operating Procedures.**

(1) All provisions of Section E.8(c) apply, except E.6(c) (3).

(2) The target-to-skin distance shall not be less than fifteen (15) inches.

(3) Notwithstanding paragraph (a) of Section C.10, personnel monitoring shall be required for all persons associated with the operation of mobile X-ray equipment.

(4) Mobile X-ray equipment shall not be used for photofluoroscopy unless it meets the requirements for mobile fluoroscopes (see Sec. E.5).

(5) The operator shall wear a protective apron or stand behind a suitable shield.

Sec. E. 10 Special Requirements for Chest Photofluorographic Installations.

(a) **Equipment.**

(1) All provisions of Section E.8(a) apply.

(2) A collimator shall restrict the useful beam to the area of the photofluorographic screen.

(b) **Structural Shielding.**

(1) All provisions of Section E.3(e) and E.8(b) apply.

(c) **Operating Procedures.**

(1) All provisions of Section E.8(c) apply.

(2) All individuals except the patient being examined shall be in shielded positions during exposures.

(3) Personnel monitoring shall be required for all individuals associated with the operation of the equipment.

Sec. E. 11 Therapeutic X-ray Installations.

(a) **Equipment.**

(1) The tube housing shall be of therapeutic type. Contact therapy machines shall meet the additional requirement that the leakage radiation at 2 inches from the surface of the housing not exceed 0.1 R/h.

(2) Permanent diaphragms or cones used for collimating the useful beam shall afford the same degree of protection as the tube housing. Adjustable or removable beam-defining diaphragms or cones shall transmit not more than five (5) percent of the useful beam obtained at the maximum possible kilovoltage and with maximum treatment filter.

(3) The filter system shall be so arranged as to minimize the possibility of error in filter selection and alignment. The filter slot shall be so constructed that the radiation escaping through it does not produce an exposure exceeding one (1) roentgen per hour at one (1) meter, or, if the radiation from the slot is accessible to the patient, thirty (30) roentgens per hour at 2 inches from the external opening. Each removable filter shall be marked with its thickness and material.

(4) A filter indication system shall be used on all therapy machines using changeable filters. It shall indicate from the control panel the presence or absence of any filter and it shall be designed to permit easy recognition of the filter in place.

(5) The X-ray tube shall be so mounted that it cannot turn or slide with respect to the aperture. A mark on the housing should show the location of the focal spot.

(6) Means shall be provided to immobilize the tube housing during stationary portal treatment.

(7) There shall be on the control panel an easily discernible indicator which will give positive information as to whether or not the X-ray tube is energized.

(8) A suitable exposure control device shall be provided to terminate the exposure after a pre-set exposure or dose limit. It shall be designed to preserve its accumulated response in the event of equipment failure during patient treatment. If a timer is used, it should permit accurate presetting and determination of exposure times as short as one second.

(9) Unless it is possible to bring the X-ray exposure rate to the prescribed value within 5 seconds after the X-ray "on" switch is energized, the tube housing on machines operating below 500 kvp shall be fitted with an "ON-OFF" shutter operated from the control panel and of lead equivalent not less than that of the tube housing. The "ON-OFF" positions of the shutter shall be indicated at the control panel.

(10) Mechanical and/or electrical stops shall be provided on X-ray machines capable of operating at 150 kvp or above to insure that the useful beam is oriented only toward primary barriers.

(11) Interlocks shall be provided for X-ray therapy equipment capable of operating above 75 kvp so that when any door to the treatment room is opened, either the machine will be shut off automatically or the radiation level within the room will be reduced to an average of not more than 2 mR/h and a maximum of 10 mR/h at a distance of one meter in any direction from the source. After such a shutoff or reduction in exposure rate, it shall be possible to restore the machine to full operation only from the control panel.

(12) The X-ray control circuit shall be so designed that it is not possible to energize the X-ray tube without resetting the X-ray "on" switch at the control panel.

(13) X-ray therapy machines shall be provided with a locking device to prevent unauthorized use.

(14) When a beam interceptor is provided, it shall transmit not more than 0.1 percent of the useful beam under any operating conditions. It shall also reduce by the same factor the radiation scattered by the patient through an angle up to 30 degrees from the central ray.

(15) When the relationship between the beam interceptor and the useful beam is not permanently fixed, mechanical or electrical stops shall be provided to ensure that the beam is oriented only toward primary barriers.

(16) Special consideration shall be given to the safety design of X-ray machines with electron beam extraction capability (i.e., linear accelerators).

(b) **Structural Shielding.**

(1) All wall, floor, and ceiling areas that can be struck by the useful beam, plus a border of one foot, shall be provided with primary protective barriers.

(2) All wall, floor, and ceiling areas that, because of restrictions in the orientation of the useful beam, cannot be struck by the useful beam shall be provided with secondary protective barriers.

(3) With equipment capable of operation above seventy-five (75) kvp the control station shall be outside the treatment room.

(c) **Operating Procedures.**

(1) A radiation protection survey of all new installations and existing installations not previously surveyed shall be made by, or under the direction of, a qualified expert. A re-survey shall be made after every change in equipment, workload, or operating conditions which might significantly increase the probability of persons receiving more than the MPD. If, as a result of a radiation survey, supplementary shielding is installed, another survey shall be made in order to confirm the adequacy of the shielding after the modification.

(2) The qualified expert shall report his findings in writing, including recommendations for any required corrective measures, to the person in charge of the installation, a copy of which shall be sent to the Department. The report shall indicate if a further survey is necessary after corrections have been made.

(3) The installation shall be operated in compliance with any limitations indicated by the protection survey.

(4) An X-ray therapy machine shall be calibrated by a qualified expert before use for the treatment of patients.

(5) X-ray therapy equipment capable of operating above 75 kvp shall not be operated routinely until the radiation safety of the installation has been established.

(6) Both the control panel and the patient shall be kept under observation during exposure.

(7) When a patient must be held in position for radiation therapy, mechanical supporting or restraining devices shall be used.

(8) No person other than the patient shall be in the treatment room where the tube is operated at potentials exceeding 75 kvp.

(9) If the X-ray tube of a contact therapy machine is hand held during irradiation, the operator shall wear protective gloves and apron. A cap of at least 0.5 mm lead equivalent shall cover the aperture window of the tube housing of such apparatus when the apparatus is not being used.

(10) Lead, lead rubber, lead foil, etc., used for limiting the field, shall not transmit more than 5 percent of the useful beam. (See Table 1.)

(11) Notwithstanding paragraph (a) of Section C.10, personnel monitoring shall be required for all persons who enter a controlled area.

Part E

TABLE 1—Thickness of lead required to reduce useful beam to 5 percent[a]

Beam Quality		Required Lead Thickness millimeters
Potential	Half Value Layer millimeters	
60 kVp	1.2 Al	0.10
100 kVp	1.0 Al	0.16
100 kVp	2.0 Al	0.25
100 kVp	3.0 Al	0.35
140 kVp	0.5 Cu	0.7
200 kVp	1.0 Cu	1.0
250 kVp	3.0 Cu	1.7
400 kVp	4.0 Cu	2.3
1000 kVp	3.2 Pb	20.5
2000 kVp	6.0 Pb	43.0
2000 kVcp	14.5 Pb	63.0
3000 kVcp	16.2 Pb	70.0
6000 kV	17.0 Pb	74.0
8000 kV	15.5 Pb	67.0
Cobalt 60	10.4 Pb	47.0

---

[a] Approximate values for broad beams. The third column refers to lead or to the required equivalent lead thickness of lead-containing materials (e.g., lead, rubber, lead glass, etc.).

Part F

USE OF SEALED RADIOACTIVE SOURCES IN THE HEALING ARTS

Sec. F. 1 Scope. The provisions of this Part apply to all licensees who use sealed sources in the healing arts and are in addition to, and not in substitution for, other applicable provisions of these regulations.

Sec. F. 2 Interstitial, Intracavitary and Superficial Applications.

(a) **Accountability, Storage and Transit.**

(1) Except as otherwise specifically authorized by the Department, each licensee shall be accountable for sealed sources and shall keep a permanent record of the issue and return of all sealed sources.

(2) When not in use, sealed sources and applicators containing sealed sources shall be kept in a protective enclosure of such material and wall thickness as may be necessary to assure compliance with the provisions of Section C.2, 5, and 6.

(3) All sources, when not in use, shall be kept in locked storage to prevent unauthorized use.

(b) **Testing Sealed Sources for Leakage and Contamination.**

(1) The licensee shall provide for testing for contamination prior to initial use. All sealed sources shall be tested for leakage at least every six (6) months. If there is reason to suspect that a sealed source might have been damaged, it shall be tested for leakage before further use.

(2) Leak tests shall be capable of detecting the presence of 0.005 microcurie of removable contamination on the sealed source. Any test conducted pursuant to Section F.2(b) (1) which reveals the presence of 0.005 microcurie or more of removable contamination shall be considered evidence that the sealed source is leaking. The licensee shall immediately withdraw the source from use and shall cause it to be decontaminated and repaired or to be disposed of in accordance with applicable provisions of Part B.

(c) **Operating Procedures.**

(1) Notwithstanding paragraph (a) of Section C.10, personnel monitoring is required for each individual who enters a controlled area.

Sec. F. 3 Gamma-Beam Therapy.

(a) Equipment.

(1) The housing shall be so constructed that, at one (1) meter from the source, the maximum exposure rate does not exceed ten (10) milliroentgens per hour when the beam control mechanism is in the "off" position. The average exposure rate measured at a representative number of points about the housing, each one (1) meter from the source, shall not exceed two (2) milliroentgens per hour.

(2) For gamma-beam equipment installed after the effective date of these regulations, the leakage radiation measured at one (1) meter from the source when the beam control mechanism is in the "on" position shall not exceed one (1) roentgen per hour or 0.1 per cent of the useful beam exposure rate.

(3) Adjustable or removable beam-defining diaphragms shall allow transmission of not more than five (5) percent of the useful beam exposure rate.

(4) The beam control mechanism shall be of a positive design capable of acting in any position of the housing. In addition to an automatic closing device, as defined in Sec. F.3 (a) (5), the mechanism shall be designed so that it can be manually returned to the "off" position with a minimum risk of exposure.

(5) The closing device shall be so designed as to return automatically to the "off" position in the event of any breakdown or interruption of the activation force and shall stay in the "off" position until activated from the control panel.

(6) When any door to the treatment room is opened, the beam control mechanism shall automatically restore the unit to the "off" position and cause it to remain there until the unit is reactivated from the control panel.

(7) There shall be at the housing and at the control panel a warning device that plainly indicates whether the beam is on or off.

(8) The equipment shall be provided with a locking device to prevent unauthorized use.

(9) The control panel shall be provided with a timer that automatically terminates the exposure after a pre-set time.

(10) Gamma-beam sources shall be tested on a six(6) month basis for leakage and contamination in accordance with the procedures described in Section F.2(b) except that the leak

tests shall be capable of detecting 0.05 microcurie of removable contamination, and a source shall be considered to be leaking if the test reveals the presence of 0.05 microcurie or more of removable contamination. Test of leakage may be made by wiping accessible surfaces of the housing port or collimator while the source is in the "off" position and measuring these wipes for transferred contamination.

(b) **Structural Shielding.**

(1) Primary protective barriers shall be provided for any area that the useful beam may strike when using the largest possible diaphragm opening. Such barriers should extend at least one (1) foot beyond the useful beam for any possible orientation.

(2) Secondary protective barriers shall be provided for all occupied areas exposed to leakage and scattered radiation.

(3) Provision shall be made to permit continuous observation of patients during irradiation.

(4) When a beam interceptor is provided, it shall transmit not more than 0.1 percent of the useful beam. It shall also reduce by the same factor the radiation scattered by the patient through an angle of up to 30 degrees from the central ray.

(5) When a beam interceptor is not present or when the relationship between the useful beam and the beam interceptor is not permanently fixed, mechanical or electrical stops shall be provided to ensure that the beam is oriented only toward primary barriers.

(c) **Operating Procedures**

(1) Paragraphs (c) (2, 6, 7) and (c) (10) of Section E.11 concerning the use of X-ray therapy equipment apply.

(2) The gamma-beam apparatus shall be calibrated by a qualified expert before use for the treatment of patients and after any alteration of the source.

(3) The gamma-beam therapy installation shall not be operated routinely until the radiation safety has been established by a radiation protection survey. The apparatus shall be operated in conformance with recommendations of the protection survey. A re-survey shall be carried out each time the apparatus is reloaded with a new source.

(4) Emergency procedures to be followed in the event of failure of the beam control mechanism shall be established and posted at the control panel.

(5) No individual other than the patient shall be in the treatment room during irradiation.

(6) Notwithstanding paragraph (a) of Section C.10, personnel monitoring is required for each individual who enters a controlled area.

Part G

REGULATIONS REQUIRING STABILIZATION OF MILL TAILINGS PILES

Sec. G. 1 Scope. The provisions of this Part apply to mining, milling or manufacturing operations where wastes, tailings piles, or stockpiled ore which contain radioactive material have accumulated.

Sec. G. 2 Permissible Concentrations and Levels of Radiation. All wastes, tailings, or stock piled ore containing radioactive material from active or inactive mining, milling, or manufacturing operations, shall be kept and maintained in such a manner as not to release to an unrestricted area radioactive material in concentrations which exceed the limits specified in Appendix A, Table II of Part C. Permissible levels of radiation in restricted and unrestricted areas as stated in Sections C.2 and C.6 of these regulations shall apply to the above material.

Sec. G. 3 Stabilization of Tailings Piles, and Ponds from Inactive Mills.

(a) Ponds shall be drained and covered with materials or provided with vegetative cover that will prevent wind and water erosion. Water drained from ponds shall be disposed of in a manner approved by the Water Pollution Control Section.

(b) Taking into consideration the types of materials at each site, piles shall be leveled and graded so that there is, insofar as possible, a gradual slope to ensure that there shall be no low places on the pile where water might collect. Side slopes shall be stabilized by riprap, dikes, reduction of grades, vegetation, or any other method or combination of methods that will ensure stabilization.

(c) If pile edges are adjacent to a river, creek, gulch, or other watercourse that might reasonably be expected to erode the edges during periods of high water, the exposed slopes shall be stabilized and the edges shall be diked and riprapped sufficiently to prevent erosion of the pile.

(d) Drainage ditches shall be provided around the pile edges sufficient to prevent surface runoff water from neighboring land from reaching and eroding the pile.

(e) The pile shall be stabilized against wind and water erosion. The method of stabilization may consist of vegetation or a cover of soil, soil containing rock or stone, cement or concrete products, petroleum products, or any other soil stabilization material presently recognized or which may be recognized in the future, or any combination of the foregoing as may be required for proper protection from wind, or water erosion.

(f) Access to the stabilized pile area shall be controlled by the operator or owner and properly posted.

(g) The pile, active and inactive, shall be maintained in such a manner that excessive erosion of, or environmental hazard from radioactive materials does not occur.

(h) The owner of the tailings pile site shall give the Department written notice ten (10) days in advance of any contemplated transfer of right, title or interest in the site by deed, lease, or other conveyance. The written notice shall contain the name and address of the proposed purchaser or transferee. Prior written approval of the Department shall be obtained before the surface area of the land shall be put to use and it shall have been determined that the radiation dosage to the public resulting from the proposed use does not exceed 0.5 rem per year.

(i) With the exception of use at a mill or for reprocessing at the site or another location, prior written approval of the Department must be obtained before any tailing material is removed from any active or inactive mill.

(j) Detailed plans for stabilizing tailings piles shall be submitted to the Department for review and approval prior to undertaking stabilization of the pile.

(k) The Department may waive individual requirements in regard to stabilization or utilization of tailings material if it can be shown that they are unnecessary or impracticable in specific cases.

(l) The effective date of this regulation shall be 45 days after the date of adoption.

MISSOULA PUBLIC LIBRARY
MISSOULA, MONTANA 59802

3 0 1981